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THE MANAGEMENT OF NEW IDEAS: AN ENTREPRENEUR'S PERSPECTIVE

by

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THE MANAGEMENT OF NEW IDEAS: AN ENTREPRENEUR'S PERSPECTIVE

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LIST OF ACRONYMS AND ABBREVIATIONS

AGC	Army Geospatial Center
APRI	Asia Pacific Research Initiative
CA	Civil Affairs
CARAT	Combined Operations Afloat and Readiness Training
CG	Commanding General
CHSC	California Homeland Security Consortium
CJSOTF-A	Combined Joint Special Operations Task Force–Afghanistan
CMOC	Civil Military Operations Center
CNTPO	Counter Narcotics Technology Program Office
CSV	Comma Separated Value
COASTS	Cooperative Operations Applied Science and Technology Studies
COIN	Counter Insurgency Operations
CORE	Common Operational Research Environment
CSV	Comma Separated Value
CV	CRIMSON VIPER
DA	Defense Analysis
DHS	Department of Homeland Security
DIA	Defense Intelligence Agency
DOD	Department of Defense
DOI	Diffusion of Innovation
DPO	DEVONthink Pro Office
FEX	Field Experiment
FI	Field interview
FIST	Field Information Support Tool
GST	General Systems Theory
GTF	Gang Task Force
HTACS	Human Terrain Analysis and Collection System
HTML	Hypertext Markup Language
ICD	Initial Capabilities Document

IED	Improvised Explosive Device
IEDNA	Improvised Explosive Device Network Analysis
IO	Information Operations
ISIS	Islamic State in Iraq and Syria
IW	Information Warfare
IWSE	Information Warfare Systems Engineering
JSOU	Joint Special Operations University
MARCIMS	Marine Civil Information Management System
MARCORSYSCOM	Marine Corps Systems Command
MARFORPAC	Marine Forces Pacific Command
MCCDC	Marine Corp Combat Development Command
MCCMOS	Marine Corps Civil Military Operations School
MCIOC	Marine Corp Information Operations Center
MCRP	Marine Corps Reference Publication
MEC	MARFORPAC Experimentation Center
MEF	Marine Expeditionary Force
MIST	Multi-modal Information Support Tool
MIST	Military Information Support Team
MSP	Massachusetts State Police
NPS	Naval Postgraduate School
NTA	Network Text Analytics
OCR	Optical Character Recognition
ODC	Office of Defense Cooperation
ODK	Open Data Kit
OSD	Office of the Secretary of Defense
OEF	Operation Enduring Freedom
OFT	Office of Force Transformation
OIF	Operation Iraqi Freedom
ONR	Office of Naval Research
ONR-G	Office of Naval Research Global
OpenFIST	Open Field Information Support Tool
ORA	Organizational Risk Analyzer

OSD	Office of the Secretary of Defense
OUSD-P	Office of the Undersecretary of Defense of Policy
OUSD-ATL	Office of the Undersecretary of Defense for Acquisitions, Technology, and Acquisitions
PACOM	Pacific Command
PCS	Permanent Change of Station
PE	Pacific Endeavor
POA&M	Plan of Action and Milestones
PoR	Program of Record
RTArF	Royal Thai Armed Forces
SCETC	Security Cooperation Education Training Center
SF	Special Forces
SITREP	Situation Report
SNA	Social Network Analysis
SOCCENT	Special Operations Command Central Command
SOCOM	Special Operations Command
SOCPAC	Special Operations Command Pacific
SOF	Special Operations Forces
SOLIC	Special Operations Low Intensity Conflict
SOTF-SE	Special Operations Task Force–Southeast
SOTF-W	Special Operations Task Force West
SPT	Special Projects Team
SSE	Sensitive Site Exploitation
TECOM	Training and Education Command
TF-IDF	Term Frequency–Inverse Document Frequency
TMT	Topic Modeling Tool
TSC	Theater Security Cooperation
USASOC	U.S. Army Special Operations Command
VSO	Village Stability Operations

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I. INTRODUCTION

A. PURPOSE OF THE STUDY

The literature on innovation is voluminous. Studies on innovation have been conducted for nearly seventy years, and research on innovation continues unabated. From the groundbreaking study on the diffusion of medicine among physicians (Coleman, Katz, & Menzel, 1957) to recent articles in the Harvard Business Review on how companies foster innovation (*On Innovation*, 2013; Anthony, Duncan, & Siron, 2014; Parmar, Mackenzie, Cohn, & Gann, 2014; Pisano, 2014; Evans, 2015), interest in innovation has not subsided. Researchers have studied innovation in business (Van de Ven, 1986; Rogers, 2010), academia (Heinze & Bauer, 2006), health care (Greenhalgh, Macfarlane, Bate, & Kyriakidou, 2004), and governmental settings (Roberts & King, 1996; Sørensen & Torfing, 2012; Bloch & Bugge, 2013; Mergel & Desouza, 2013; Roberts & Longley, 2013; Gil-Garcia, Helbig, & Ojo, 2014; Zheng & Zheng, 2014; Choi & Chandler, 2015; De Vries, Bekkers, & Tummers, 2015). The vast knowledge on innovation has led to a better understanding of what innovation is (Rogers, 2010), how and under what condition innovation occurs and can be fostered (Nohria & Gulati, 1996), encouraged (Anderson & West, 1998), and how innovation can lead to change in an organization (Burkhardt & Brass, 1990). Despite the significant amount of research on the topic, our understanding of innovation is incomplete.

For this study, I have adapted a process definition of innovation that enables the exploration of how ideas become innovations within an organizational context, while maintaining clarity between invention—the creation of something new to the world—and innovation—the evolution of an idea through its development into practice. A process study, such as this one, focuses on how innovation occurs rather than on what determines innovation outcomes. For this study, I define innovation as a social, interactive, and dynamic process—characterized by the exchange of knowledge and information—in which problems are defined and solutions are developed, refined, and implemented. Within the innovation process, the unit of analysis is an idea.

1

This dissertation presents an empirical study of bottom-up innovation in the DOD. It draws on a single case—the development of a mobile data collection system for sociocultural and ethnographic intelligence—and focuses on the role of the entrepreneur in managing and communicating the idea over time. This study also updates and expands the findings from previously published works on the interaction between entrepreneurship and innovation (Roberts & Longley, 2011; Roberts & Longley, 2013). The case study has been expanded with data from mid-2010 to mid-2016 and probes the earlier findings with greater depth by incorporating additional analytic methods to include semantic network analysis, topic modeling, and lexical analysis to track the idea and its evolution over time.

In our previous research (Roberts & Longley, 2013), we identified six conditions for bottom-up innovation and entrepreneurship to be successful in the DOD—the management of the idea's identity and meaning; the management of attention; the management of resistance and conflict; the management of the network; the management of organizational interfaces; and the management of tensions (Roberts & Longley, 2013). This study probes the conditions in greater depth by focusing on the development, management, and communication of an idea over time to address two research questions.

1.   Research Questions

The first research question, ***"How do ideas develop and evolve over time as they move through the innovation process?"***, explores the chaotic and messy path ideas travel when moving through the innovation process. This question is motivated by the findings from Schroeder, Van de Ven, Scudder and Polley (1989) that tracked idea management and the development of innovations across seven different case studies from the Minnesota Innovation Research Project. More specifically, this research probes the proposition that innovation is often stimulated by a shock to an organization, and ideas splinter into several different ideas during the innovation process. In both the case analysis and the quantitative analysis, this research explores the validity of that proposition and suggests a more nuanced understanding of idea development shaped by the deliberate and purposeful management of the communication of that idea.

The second question, ***"How do entrepreneurs manage the meaning of an idea as it evolves over time?"***, expands the exploration of the communication of the idea by exploring the narratives used to communicate the central idea and the narratives crafted by an entrepreneur and his team to gain acceptance and support for the idea. The study explores the role of narratives in shaping innovation (Bartel & Garud, 2009) and leverages the coordinated management of meaning theory (Pearce & Cronen, 1980) to understand the interactions between the entrepreneur and the audiences to whom the idea is conveyed.

2.   Significance of Study

This study provides a unique, bottom-up perspective of innovation in the DOD informed by the innovation and entrepreneurship literatures. It also provides a longitudinal exploration of the activities of an entrepreneur[1] and his team in moving an idea from concept to implementation through the complex and bureaucratic processes within the DOD. In addition to the case study, this research includes a quantitative analysis of the insights generated to reinforce and enrich the findings of the study.

As innovation is vital for transformation, this research will contribute to the literature on bottom-up innovation within the public sector, and provide additional support to the growing chorus of practitioners championing alternative models for innovation within the DOD to address the Department's challenges of encouraging, supporting, and implementing innovation.

B.   CONTEXT OF STUDY

In the following section, I describe the context of the study framed in terms of three conditions with which this research is conducted. The first condition, public sector innovation, focuses on the innovation and entrepreneurial processes within the public

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[1] As of the date of this publication, I believe this dissertation is the first such example of an entrepreneur writing his story in a dissertation and systematically analyzing what he did, how he did it, and why he did the activity described herein. While previously published work (Shamiyeh, 2010) include first hand perspectives from an entrepreneur, the interviews were conducted well after the fact and were retrospective in nature. The analysis paired with the interviews reflected on the general themes of the book and not on the actual statements of the entrepreneur.

sector. While I reference material in this dissertation that is applicable across sectors, the focus of this study is firmly nested within the public sector. The second condition of this study focuses on a specific public sector organization of—the DOD. Finally, this study focuses on the innovation process by taking a bottom-up perspective rather than the prevailing top-down perspective. Each of these conditions is now described in further detail.

1. Public Sector Innovation

Interest in innovation is due in large part to the growing consensus that innovation is critical for the success of organizations (Bower & Christensen, 1996). Without fresh ideas and new ways of improving and enhancing capabilities, and developing new products or processes, organizations become stagnant. The larger and more established an organization becomes, the more likely it is "to have a large repertoire of structures and systems in place that discourages innovation while encouraging tinkering" (Van de Ven, 1986, p. 596). Tinkering around the edges can increase the risk of an organization's falling behind competitors or losing relevance for its customers.

Although a significant amount of the innovation literature focuses on the innovation impetus in business organizations, an emerging thread of material has appeared in the literature on innovation in the public sector (Sørenson & Torfing, 2012). This line of research shifts the discussion from one of innovation as a driver of profitability to one of innovation as a driver of new policies and programs. Thus, we find researchers conducting innovation studies within the public service sector in a variety of contexts from policy advancement to the search of solutions to complex problems (Sørensen & Torfing, 2012). Indeed, in public service innovation, many see the government as an engine for promoting innovation. One government organization, the United States Department of Defense (DOD), has expressed an interest and championed innovation for decades (Grissom, 2006).

2. Innovation in the DOD

After more than 14 years of conflict since 2003, the DOD is faced with a myriad of complex challenges that include an increasingly unstable situation in the Middle East,

a continuation of budget reductions known as sequestration, the end of two of America's longest running military operations since Vietnam, China's increasingly dominant role on the international stage, North Korea's continued defiance of United Nations resolutions, Russia's aggressive behavior in the former Soviet Bloc, U.S. and allied counter-terrorism operations around the globe, and the fight against the Islamic State in Iraq and Syria (ISIS). To maintain a trained and equipped fighting force, develop new capabilities for tomorrow's threats, and do so in a resource-constrained environment, what can and should the DOD do to address these challenges? How can the agency best maximize the lessons identified over the past decade regarding training, education, materiel, work force management, and technology development to posture itself properly for the decades to come?

The solutions to these challenges are varied, but there is nearly universal agreement that a departure from the status quo is required. Many argue that transformative change is the key, but what does transformation mean for the DOD?

Transformation is the overarching concept that describes the process required for the DOD to remain competitive on the global stage during an ever-changing security landscape, while challenging the status quo to create new and better ways of doing business during times of fiscal austerity (Alberts, 2002). Transformation is, like innovation, a process whereby new ideas are imported, refined, experimented with, and implemented within the organization to achieve a measured improvement in the status quo. The DOD has spent a considerable amount of effort thinking about transformation and has even effected structural changes within the organization to realize these goals. In 2001, the DOD established the Office of Force Transformation (OFT) within the Office of the Secretary of Defense (OSD). The OFT was charged with implementing the vision of then Secretary of Defense Donald Rumsfeld which aimed to transform how the DOD was manned, trained, and equipped. The OFT was envisioned as being a "catalyst for entrepreneurial and experimental thinking in defense policy and thinking" (Rogin, 2006, p. 1). In 2006, the OFT was officially disbanded with the functions of the office spread between the Office of the Under Secretary of Defense for Policy (OUSD-P) and the Office of the Undersecretary of Defense for Acquisition, Technology, and Logistics

(OUSD-ATL).[2] While OFT is no longer in existence, the need to transform did not go away.

Transformation is required to change how the DOD does business, where it invests its resources, and where it focuses its efforts. Transformation will require new and fresh ideas, process and product improvement, improved ways of training, organizing, educating, fighting, and a willingness to challenge the status quo. Transformation of this magnitude will be disruptive. It will take time, energy, and considerable resources, but this change will better position the DOD to face the challenges now and in the future. The central driver of this transformative process will be the DOD's ability to innovate.

Within the DOD, publications espouse the importance of innovation in the transformation process. Marine Corps Reference Publication (MCRP) 6–11D *Sustaining the Transformation* is a prime example of a departmental publication (published by the Marine Corps) that emphasizes, among other things, the need to innovate to stay ahead of the changing pace of the complex environmental and security challenges the Marine Corps faces in the coming years. Innovation, as the Marine Corps argues, is critical for its long-term success and that of the DOD. The last three secretaries of defense have expressed interest in innovation and have for years called for large-scale innovative initiatives throughout the Department (Fryer-Biggs, 2012; Freedberg, 2014; Hagel, 2014; Pellerin, 2015). The previous Secretary of Defense, the Hon. Dr. Ash Carter, has espoused the importance of innovation for leading the DOD into the 21st century. To meet the complex challenges the Department faces, the Secretary has launched an initiative to engage and partner with Silicon Valley, to harness the innovative spirit of the corporate world and import it into the DOD (Pellerin, 2015)—an initiative that continues with the now Secretary of Defense, General James Mattis.

3.   Competing Perspectives of Innovation: Top-Down versus Bottom-Up?

While innovation is often championed as the answer to a variety of problems the Department faces, innovation within the Department remains challenging. Numerous

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[2] https://fcw.com/Articles/2006/09/04/DOD-decides-to-close-Office-of-Force-Transformation.aspx.

studies of military innovation acknowledge the difficulty of innovating within a bureaucratically inflexible and change-resistant organization (Grissom, 2006; Ucko, 2009; Adamsky, 2010; Farrel, 2010). The military's model for innovation assumes a top-down approach, requiring external authority and management (Grissom, 2006). This view of innovation is based on the idea that decision makers at the top of the organizational hierarchy identify problems, recommend solutions, and work to implement these solutions within the established structures and processes that are in place. According to Grissom (2006) as summarized by Ucko (2009, p. 16), "the over-riding focus on top-down innovation obscures the critical role played by bottom-up initiatives in pushing an organization forward."

Despite the organizational resistance to change and the top-down view of innovation, there are empirical studies of bottom-up innovation that provide valuable insights into an alternate model of innovation (Hubbard & Ottoson, 1997; Grissom, 2006; Bergman, Markusson, Connor, Middlemiss, & Ricci, 2010). These studies offer an alternative model as a counter-argument to the assumptions and frameworks about top-down innovation.

In an organization where guidance and direction are provided from the top down in a change-resistant medium, how does the Department effectively organize, foster, and encourage innovation within its ranks? The answer may lie in researching models of innovation that are bottom-up rather than top-down.

C.   STRATEGY OF INQUIRY

To orient the reader to the broader research strategy for this dissertation, Figure 1 provides a graphical representation of the overarching system of inquiry. This graphic displays each major section of this dissertation—literature review, case study, quantitative analysis, and findings—and details both the inputs to each section and the outputs. In each chapter, I will revisit the graphic to orient the reader to overarching research strategy. I will now briefly describe how these components fit together before transitioning into a review of the overall structure of the entire dissertation.

Research Strategy

1. How do ideas develop and evolve over time as they move through the innovation process?

2. How do entrepreneurs manage the meaning of an idea as it evolves over time?

Literature review | Case Study | Quantitative Analysis | Findings

Conditions:
- Public sector
- DoD
- Bottom-up (micro)

Inputs:
- *Insights* generated from case study

Innovation process
unit of analysis: the idea

Entrepreneurial process
unit of analysis: entrepreneur's activities in managing and moving an idea through the innovation process

Innovation Entrepreneurship Management of Ideas

Entrepreneur's experiences, lived reality, and *initial idea*

Archival Records

Case development and evolution of the idea

Archival Records

Semantic Network Analysis

+

Topic Modeling

+

Lexical Analysis

Insights from Case Study

+

Findings from Quantitative Analysis

Focus:	Outputs:	Outputs:	Outputs:
• Interconnection of innovation and entrepreneurship • Management of ideas, • Confounding of *units of analysis* • The absence of *differentiation* between levels of analysis	Two *insights* about the management of ideas *1. The core idea of the innovation remains constant* *2. Narratives shift over time to reframe the idea to garner support*	• Quantitative analysis of the *communication of the idea* • Evidence supporting the insights identified in the case study (qualitative analysis)	• Two propositions generated about the management of ideas • Refined model of entrepreneurship • Contributions of study

Figure 1.   Research Strategy Map—Inputs, Outputs, and Processes

The literature review for this dissertation is comprised of three main bodies of literature—literature on the innovation process, literature on the entrepreneurial process, and literature on the management of ideas. The focus of the literature review is on the interconnect of innovation and entrepreneurship with an emphasis on the management of ideas. I discuss the confounding of terminology and units of analysis in the literature and identify the issues with the differentiation between levels of analysis in the management

of ideas. The outputs from the literature are the identified gaps in the field and the motivation for exploring the case in this study.

After the literature review, I transition into the case study which is nested within a specific context (conditions)—public sector, DOD, and bottom-up. The conditions for the case study (identified as inputs) nest this study as one that is focused on innovation within a large, public-sector organization (DOD) that adopts a bottom-up perspective to probe and explore three major components of the case study. The three components are (1) the entrepreneur's experiences, lived reality, and initial idea, (2) the archival records pertaining to the case, and (3) the case development and evolution of the idea through time. From the case study, I present two insights about the management of ideas. The first insight deals with the consistency of the central idea behind the innovation and the second insight deals with the reframing and shifting of narratives to attract and garner support. These insights serve as inputs into the subsequent quantitative analysis.

Beginning with the insights generated from the case study, I probe the archival records using a combination of three related, but separate text analysis procedures to reinforce or refute the observations made from the case study. The outputs from the quantitative analysis focus on the communication of the idea and present evidence supporting the insights developed during the qualitative analysis in the case study.

Finally, the insights from the case study are blended with the findings from the quantitative analysis to develop and propose two propositions about the management of ideas. In addition to the two propositions, I present a refined framework of entrepreneurship and discuss the major contributions of the study.

D.   DESCRIPTION OF STUDY

This study blends a longitudinal case study with a quantitative lexical analysis to explore how an entrepreneur and his team manage and communicate a new idea as it is moved through the innovation process. The design offers a more nuanced, detailed, over-time exploration of the topic in a natural setting. Most germane to this study, it enables the exploration of a complex inter-relationship between the innovation process and the entrepreneurial process in the DOD and grounds the experience in the lived reality of the

study participants. By opening a window on the entrepreneurial and innovation process, it facilitates theoretical development (Hodkinson & Hodkinson, 2001) between the two processes.

For this study, I attempt to mitigate the question of objectivity and lack of generalizability of the findings by integrating a quantitative analysis on the archival records to probe the observations and insights generated out of the case study. This approach, referred to as transformative mixed methods, "uses a theoretical lens as an overarching perspective within a design that contains both quantitative and qualitative data. This lens provides a framework for topics of interest, methods for collecting data, and outcomes or changes anticipated by the study" (Creswell, 2013, p. 15). Thus, by using a transformative mixed-methods approach I explore the management and evolution of an idea through the innovation process with both a qualitative and quantitative perspective.

1. The Idea: A Smartphone Mobile Data Collection System

While attending the NPS and working on my master's thesis, I was exposed to emerging technology and analytic methods aimed at improving the data and information challenges the U.S. military was experiencing while operating in austere environments. At the same had, Apple had released the first iPhone[3] in 2007 followed shortly thereafter by Google's G1[4] in late 2008. For the first time (notwithstanding the antiquated Window Mobile platform that pre-dated both Apple and Google's offerings), mobile app development became a viable approach to enabling data collection using the devices each soldier, sailor, Marine, and airman had in their hands.

Because of this exposure to technology and emerging methodologies, I conceived of an approach to develop and demonstrate a mobile data collection and analysis platform

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[3] The initial iPhone press release can be found online at: http://www.apple.com/pr/library/2007/01/09Apple-Reinvents-the-Phone-with-iPhone.html.

[4] The original Google phone, known as the T-Mobile G1, press release is available online at https://newsroom.t-mobile.com/news-and-blogs/t-mobile-unveils-the-t-mobile-g1-the-first-phone-powered-by-android.htm.

for field use. By leveraging commercial off-the-shelf, open source, and free software in a deliberate, integrated fashion, smartphone based mobile data collection could provide an inexpensive, yet viable solution for the data collection challenges facing the military at that time. While the initial data collection idea was framed around the narrative of a tool to support human terrain mapping—a topic of considerable interest at the time—the application of smartphone based data collection was not limited to sociocultural data collection alone. Mobile data collection could be used to collect geospatial, media-rich data from the field and transfer this information across various data paths—cellular and wireless networks—to analysts and commanders globally. As a result, the idea would be framed in different contexts for different audiences to attract interest and garner support.

In its most basic form, the central idea that kick started my research for the next several years could be best described as the development of smartphone application to permit the systematic collection of structured and socio-culturally relevant data from remote and austere environments.

2. Study Setting

This study takes place over a seven-year period (2009–2016). From 2009 to 2012, I was a student and researcher at NPS in Monterey, California. NPS provides a unique setting for conducting mixed-method longitudinal research. The school sits at the intersection of the DOD and civilian research communities, serving as a scientific hub that connects a diverse and divergent group of military, civilian, and international students, faculty, and researchers.

From 2012 to 2016, I moved from a position of influence and control over the research program to an outside observer when I was transferred to other units within the DOD. Although at different organizations, I still maintained connectivity with and maintained awareness of Lighthouse as it evolved.

This research takes place within the organizational context in which the innovation process was nested: the DOD. The DOD was chosen as a convenience sample in which to study the innovation process. Because the new idea was firmly nested and created within the DOD, it is only appropriate that I study and discuss this experience as

it pertains to the organization in which it was created and nurtured. From 2009 to 2012, the DOD faced a significant budget-constrained environment known as sequestration. Discussions permeated the service on the need for cheaper, more effective solutions, and there was a general desire to harness commercial off-the-shelf technology to achieve this desired goal.

Because this research was interested in the development of a new idea and the management of the idea over time, the DOD enabled the observation and monitoring of patterns of interaction within and outside of the formal channels defined by the organizational structure. Since innovation tends to be a cross-boundary effort (Obstfeldt, 2005; Bell, 2005; Bogers & West, 2012; Hemphälä & Magnusson, 2012), studying these cross-boundary interactions is possible and more easily distinguishable in the DOD than in other organizations, especially when one is a member of the organization and can interpret and understand the culture more easily than can an outsider.

Finally, the DOD[5] was determined to be an important organization in which to explore the innovation process due to the unique nature in which innovation policy and guidance are directed from the top-down, but implementation occurs through bottom-up processes. This study provides an alternative perspective of the innovation process and narrative within the DOD that focuses on bottom-up innovation rather than the dominant top-down perspective.

3.   Data Collection Strategies

This case study includes many data collection strategies employed to provide a robust description and recollection of the events surrounding the case. These include the use of first-person experiences and observations, temporal and relational data, and crosschecking with more than seven years of archival data.

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[5] The DOD is a massive, public sector organization. A full list of organizations within the DOD that are included in this study is available in Appendix C.

a. Archival Records

This study incorporates a variety of archival data sources to ensure an accurate and detailed recollection of the events of the case study. Archival data sources used in this study include published reports, travel documents, meeting notes, briefings, news articles, and email archives. These data sources have been analyzed for both content and relational ties.

b. Participant-Observation

This dissertation features a unique factor that differentiates it from other innovation studies. First, my role in this study is both participant and researcher. The case study takes place over several years in which I was both the primary participant communicating and driving a new idea through the innovation process, and after conducting a permanent change of station (PCS) move in 2012, I became a researcher—an outside observer of the process. As primary participant and later researcher/observer of the process, I could observe the entrepreneurial and innovation processes from both an insider's perspective (as the lead entrepreneur managing the communication and development of the idea) and an outsider's perspective (as a member of an outside organization observing the process from afar). This dual role provided a unique perspective of two different viewpoints of the phenomena and helps to minimize the theoretical tensions within qualitative research between the two perspectives (Godina & McCoy, 2000). This combined perspective allowed for both a nuanced understanding of the insider's view of the process as well as an outsider looking in after the fact.

4. Data Analysis Procedures

In addition to the data collection strategies briefly discussed, this research incorporates a longitudinal semantic network analysis, topic modeling, and lexical analysis of the archival data. The semantic and lexical analysis enables the researcher to visualize and analyze empirically the changes to the communication and description of the new idea over time. In the context of this research, changes in the semantic networks identify the changes to the description of the new idea as it moved through time.

5. Verification

In this study, I am both a participant and an observer in the case study. While this dual perspective is discussed as a unique variable of the study, the potential for bias is a concern and has the potential to skew results. To minimize bias, I use external participants to verify the events as described. Additionally, the incorporation of a quantitative analysis on the archival data increases the reliability of the information contained in the case and strengthens the propositions generated in the final chapter.

E. STRUCTURE OF THE DISSERTATION

In the following section, I provide a general summary of activity in each chapter of the dissertation. Each section highlights the major components of the chapter and provides a brief narrative to orient the reader.

1. Introduction

Chapter I of the dissertation introduces the topic of entrepreneurship and innovation and provides the motivation for studying innovation within the DOD. The chapter provides an overview of the structure of the dissertation and the research strategy used to guide this multi-faceted and complex inquiry. I describe the mixed-methods approach used to understand and track the evolution, development, and communication of a new idea over time and the role the entrepreneur plays in the management of that idea. The three conditions of the study—public sector, DOD, and bottom-up—are introduced as they are both unique to the study and ground the propositions generated in the final chapters of the dissertation.

2. Literature Review

In Chapter II, I provide the reader with an overview of the innovation literature. In this exploration, I highlight the multitude of definitions used to describe the term "innovation" and focus on the process view of innovation to guide the discussion. Additionally, I focus on the literature surrounding innovation in the public sector as the case is firmly situated in a public-sector organization—the DOD.

Following the introduction of innovation, I discuss the literature on entrepreneurship and point to the touch-points between innovation and entrepreneurship. I highlight the need to explore and understand the interaction between both innovation and entrepreneurship in the context of public sector innovation. I discuss entrepreneurship studies that focus on the characteristics of the entrepreneur and the activities the entrepreneur conducts to move an idea through innovation process. To disambiguate the discussion between innovation and entrepreneurship, I present a model from Roberts and King (1996) that provides the clarification needed to synthesize both entrepreneurship and innovation.

Out of this review, I identified several studies on innovation and entrepreneurship that provide clarification on what describes an innovation, the steps a new idea will move through during the innovation process, and focus on the role of management in the innovation process. A key article of reference—Schroeder et al. (1989)—serves as foundational piece of literature that I revisit throughout the dissertation. This article focuses on the various paths ideas take in the innovation process—an idea that I expand and offer an alternative view in the case analysis and findings of the chapter. Using an interpretive governance theory of innovation (Bevir & Rhodes, 2006; Bevir & Richards, 2009, Bevir, 2010) I present an alternative view of the management of new ideas that is based on the actions of individual actors.

Following the discussion on idea management, I conclude the chapter with the motivation for conducting the study within the context of innovation in the DOD. Given that the DOD is an organization where guidance and direction are provided from the top down, and ideas and new tactics, techniques, and procedures are developed from the bottom up, I suggest that the key to understanding innovation in the DOD may be unlocked by studying the interaction between the innovation and entrepreneurial processes while incorporating an interpretive governance theory of innovation.

3.   Methods

Chapter III describes the methodological approach to study and explore innovation in the DOD using a transformative mixed methods approach. In this chapter, I

detail the research design chosen for this study. Using a case study with a variety of text based analytic methods, I lay out the data collection strategies employed to ensure a reliable and accurate representation of the innovation process at the idea level. Additionally, I detail my reasoning behind blending a case study with a quantitative analysis to develop a more nuanced understanding of the evolution of new ideas over time and the role the entrepreneur plays in managing these ideas during the innovation process. I emphasize the data collection, management, and analytic processes used to develop the results detailed in the case description, case analysis, and quantitative analysis that follow this chapter.

4.   Case Study

In Chapter IV, I present the description of the case beginning with a chronological narrative that describes the history and development of the new idea, and tracks its creation, design, and development at NPS in Monterey, California, from 2009 to 2016. These narrative tracks the evolution of the project from idea to implementation through a messy and chaotic path. Following the case description, I provide a brief analysis of the case and generate two insights about the management of new ideas within the specific conditions that bound the study—a study on entrepreneurship and innovation in a large, public sector organization that explores idea management at a micro, rather than macro level.

The chapter concludes with the insights gained from a qualitative analysis and transitions into an empirical "test" of the insights using a quantitative analysis. This approach was used to reinforce or refute the insights obtained from the case analysis and mitigate any issues caused by relying on observation alone.

5.   Quantitative Analysis

After the description of the case and the initial analysis conducted on the descriptive data, I present a quantitative analysis that begins with the insights generated from the case study. These insights are tested by conducting a quantitative analysis on the archival records using three related, but distinct analytic methods. These three methods— semantic network analysis, topic modeling, and lexical analysis—enable me to explore

and analyze the communications of the new idea by the entrepreneur and his team over time. This analysis is used to provide additional empirical support to the generated insights from the case study by tracking analyzing the words and concepts used to describe the idea and the narratives that support the idea.

By combining three different text analytic approaches to analyze the entrepreneurial efforts to manage the meaning of the new idea over time, I generate additional evidence to support the two insights generated in the case analysis.

I began the analysis with semantic network analysis to identify core concepts and links between these concepts within the archival records. By identifying core concepts such as *data, collection, core, lab,* and *sna* throughout the corpus, I provide evidence of support for the core concept proposition before conducting a more detailed analysis using a communicative power analysis and community detection approach to analyze the semantics for both propositions.

Following the semantic network analysis, I introduce topic modeling to analyze the based on the frequency and distribution of words within each document and compare these results to the corpus. From the topic modeling, I provide additional evidence to support the persistence of terms used to describe the central idea.

Finally, I incorporate a variety of lexical analysis techniques to compare documents over to understand the changes to the idea over time. Using dendrograms and Voronoi diagrams, I provide further support for the similarity of the documents and the concepts within that suggest a deliberate management of the idea and narratives over time.

In this chapter, I present empirical support to the idea that as the lead entrepreneur in collaboration with an entrepreneurial team, we managed and communicated various narratives of the idea differently throughout the 15 periods of time to garner interest from different organizations and individuals while maintaining consistency with a core central idea. The central idea—a field data collection tool to support sociocultural analysis—remained unchanged throughout all time periods. The different narratives—sociocultural dynamics, civil military operations, village stability operations—were reflective of the

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efforts of the entrepreneur describe and present the central idea to different audiences to garner support. The quantitative analysis presented supports both insights generated in the case analysis.

6.   Discussion and Conclusion

In Chapter VI, I present the findings of this study that incorporates both the insights from the case analysis and the results of the quantitative analysis. The chapter takes the insights from the case analysis and combines them with the findings from the quantitative analysis to generate two propositions on the management and communication of ideas.

The generated propositions update previously published research (Roberts & Longley, 2011; Roberts & Longley, 2013) by blending a case analysis with a quantitative analysis. The methods used in this study enables a deeper exploration of the innovation process by stage, informed by a relational perspective, and explores the interaction between the development of an idea and the entrepreneurial activity required to move an idea through an organization over time.

By blending these two approaches, I work to explain how this approach has helped to answer the primary research questions of the study. The propositions generated add to the existing literature on idea management and suggest merit in studying the management of ideas at a micro, rather than macro level.

Following the discussions of the findings, I conclude the dissertation by addressing the major contributions of the study, and discuss the implications of these findings for current and future research.

II.   LITERATURE REVIEW

A.   OVERVIEW

To anchor the literature review in the overarching research strategy, Figure 2 highlights the structure of the literature review and the focus within this chapter.

Research Strategy

1. How do ideas develop and evolve over time as they move through the innovation process?

2. How do entrepreneurs manage the meaning of an idea as it evolves over time?

Literature review	Case Study	Quantitative Analysis	Findings

Conditions:
- Public sector
- DoD
- Bottom-up (micro)

Inputs:
- *Insights* generated from case study

Literature review:
- Innovation process *unit of analysis: the idea*
- Entrepreneurial process *unit of analysis:* entrepreneur's activities in managing and moving an idea through the innovation process
- Innovation Entrepreneurship Management of Ideas

Case Study:
- Entrepreneur's experiences, lived reality, and *initial idea*
- Archival Records
- Case development and evolution of the idea

Quantitative Analysis:
- Archival Records
- Semantic Network Analysis
  +
- Topic Modeling
  +
- Lexical Analysis

Findings:
- Insights from Case Study
  +
- Findings from Quantitative Analysis

Focus:
- Interconnection of innovation and entrepreneurship
- Management of ideas,
- Confounding of *units of analysis*
- The absence of *differentiation* between levels of analysis

Outputs:

Two *insights* about the management of ideas

1. *The core idea of the innovation remains constant*

2. *Narratives shift over time to reframe the idea to garner support*

Outputs:
- Quantitative analysis of the *communication of the idea*
- Evidence supporting the insights identified in the case study (qualitative analysis)

Outputs:
- Two propositions generated about the management of ideas
- Refined model of entrepreneurship
- Contributions of study

Figure 2.   Research Strategy–Literature Review Components and Focus

The literature on innovation spans nearly seventy years and continues unabated. As introduced in Chapter I, the interest in innovation is due to the overwhelming consensus that innovation is critical for the success of organizations (Bower & Christensen, 1996; Sørenson & Torfing, 2012).

This literature review begins by discussing the wide use of definitions and taxonomies to conceptualize and discuss innovation. It then explores how existing conceptualizations of the innovation process focus narrowly on ambiguously defined stages (e.g., diffusion) and tend to dismiss the activities required in the beginning stages of the innovation process while focusing on characteristics of organizations and users only at the end of the process. Although a relational perspective is common among innovation research (Greenhalgh et al., 2004), many studies focus on the role of social networks in the diffusion stage (Abrahamson & Rosenkopf, 1997) rather than view networks as conduits for communicating and refining a new idea throughout the innovation process (de Lancer Julnes, 2015). This imbalance in the literature may partly explain the pro-innovation bias claims in the literature (Abrahamson, 1991), our incomplete understanding of how ideas move through the innovation process, and the confusion over the management of ideas over time (entrepreneurial activity).

The review presents a revised conceptualization of the innovation process that addresses the stages of innovation. Within this framework, I incorporate the language of design thinking to provide context to the act of innovating (Brown, 2008). Design thinking informs how we describe the development steps within the innovation process and removes the "black box" myth and the oversimplification of the innovation process frequently found in the literature today.

I then turn to a discussion on entrepreneurship to further clarify issues in the innovation literature that *confounds the idea* as the *unit of analysis* with the managerial *activities of an entrepreneur and his supporters* as the *unit of analysis*. The two processes of innovation and entrepreneurships are often blended together, not only in the innovation literature, but the network literature as well. This research treats both processes as independent, but connected processes with *two separate units of analysis*. The *unit of analysis in the innovation process is the idea itself*, whereas the unit of *analysis of the*

entrepreneurial process is "the entrepreneur and the relational network of activities he/she develops in support of the innovative idea" (Roberts, 1992; Roberts & King, 1996; Roberts, 2007; Roberts & Longley, 2013, p. 179).

Finally, this chapter concludes with a discussion on the key insights from studies from the innovation and the entrepreneurship literature. This summary identifies the theoretical gaps that motivate this dissertation research.

B.   INNOVATION

The term *innovation* is defined in a variety of ways by several different authors (Godin, 2006). The diverse definitions of innovation and the various frameworks proposed by researchers can be confusing as there is often general disagreement on whether innovation is a concrete concept or merely a label applied to a concept (Pollit, 2011). Writers interchangeably use the terms *innovation* and *invention* with little regard for delineating the terms; as such, the difference between innovations and new ideas remains ambiguous. To highlight the variance in the definitions of innovation, Table 1 displays several definitions of innovation as found in the literature.

Table 1.   Innovation Definitions

Definition	Reference
"Change which is new to the organization and to the relevant environment."	Knight, 1967, p. 478
"A process whereby new thought, behavior, or thing which is qualitatively different from existing forms is conceived of and brought into reality."	Robertson, 1967, p.19
"Innovation is not a single action but a total process of interrelated sub processes. It is not just the conception of new idea, or the invention of a new device, nor the development of a new market. The process is all these things acting in an integrated fashion."	Myers & Marquis, 1969, p. 14
"The development and implementation of new ideas by people who over time engage in transactions with others within an institutional context."	Van de Ven, 1986, p. 591
"Innovation is not always based on an invention, but may also involve identifying, translating and adjusting new ideas and solutions from other countries, policy fields or organizations. Hence, it is not the origin of new solutions, but rather the context in which they are implemented that determines whether they are new and innovative."	Roberts & King, 1996 as summarized by Sorenson & Torfing, 2012, p. 4
"An idea, practice, or object that is perceived as new by an individual or other unit of adoption."	Rogers, 2010, p. 11
"The creation of value through a new match between a problem and a solution."	Terwiesch & Ulrich, 2006, p. 1
"Innovation is the implementation of novel ideas or processes."	Paulus & Dzindolet, 2008, p. 1

Definition	Reference
"A dynamic process through which problems and challenges are defined, new creative ideas are developed, and new solutions are selected and implemented."	Sørensen & Torfing, 2012, p. 4
"Innovation is a social and interactive process in which collaboration and exchange of knowledge and information play crucial roles."	Hemphälä & Magnusson, 2012, p. 1
"We can think of the innovation process as consisting of a series of hurdles or transformations that move the new idea from its initial to its final state."	Roberts & Longley, 2013, p. 178

Starting with Robertson (1967), innovation is regarded as a process rather than a singular, discreet event. He understands the innovation process as "a process whereby new thought, behavior, or thing which is qualitatively different from existing forms is conceived of and brought into reality" (Robertson, 1967, p. 19). The process view of innovation has been adopted by numerous researchers and is firmly anchored throughout the innovation literature (Van de Ven, 1986; Roberts & King, 1996; Trott, 2008; Terwiesch & Ulrich, 2006; Sørensen & Torfing, 2012; Hemphälä & Magnusson, 2012). For my purposes, innovation is conceptualized as the evolution of an idea through its development into practice (Roberts, 2010).

Just as there is a broad variance in the definition of innovation, there are an equal number of variations in what defines the stages or steps in the innovation process or if the process should even be viewed with a stage model at all (Schroeder et al., 1989).

For those that support a stage-based model of the innovation process, there is some consensus on the taxonomy of the stages: *idea creation* (Nonaka, 1994; Cockayne, 2004; Kijkuit & Van den Ende, 2007), *product development* (Brown & Eisenhardt, 1995; Lilien, Morrison, Searls, Sonnack, & Hippel, 2002; Ottenbacher & Harrington, 2007), *product and process improvement* (Terwiesch & Ulrich, 2006), *adoption* (de Lancer

Julnes, 2015), and *diffusion* (Coleman et al., 1957; Robertson, 1967; Abrahamson & Rosenkopf, 1997; Wejnert, 2002).

Unfortunately, many innovation studies have approached the stages of the innovation process in a "monolithic" manner and treat concepts like "adoption" or "diffusion" as discreet rather than continuous events (de Lancer Julnes, 2015). This singular, linear approach to studying innovation fails to address the natural ebb and flow of ideas throughout the innovation process (de Lancer Julnes, 2015).

Perhaps the biggest offender of this monolithic view of innovation is the literature on the diffusion of innovation. The Diffusion of Innovation (DoI) theory, published in 1962 by Everett Rogers, dominates innovation research today. Studies that have adopted this framework have focused on how, why, and at what rate innovations spread through various organizations and cultures (Rogers, 2010). While early diffusion studies examined the individual behaviors of adopters (Burt, 2004), a shift occurred that studied innovation at the group and organizational levels (Baldridge & Burnham, 1975). The DoI theory became a key theoretical base for the innovation-diffusion literature. In fact, diffusion studies form many of the works in the innovation literature field (Greenhalgh et al., 2004), although Rogers's treatment of the phenomena is but one of the multitude of theoretical developments that have since been developed (Burt, 1987; Obstfeldt, 2005; Fleming, King, & Juda, 2007; Bogers & West, 2012).

The DoI literature, however, is not without its critics (Nelson & Winter, 1977; Lyytinen & Damsgaard, 2001; Jeyaraj, Rottman, & Lacity, 2006). The emphasis on the diffusion stage of the innovation process at the expense of all the other stages provides limited theoretical insights into the process of innovation. To illustrate this point, imagine that a new information technology system was developed and deployed within an organization. The upper management of that organization decided they wanted to understand how this new system came to be to replicate this process with new innovations. If we adopt the dominant theoretical lens—the diffusion of innovation theory—and attempt to understand the process, we realize that the DoI theory provides limited context into the stages in the innovation process required to identify, develop, and implement subsequent innovations within an organization. Diffusion only tells us one

aspect of the innovation process. If we want to understand and identify the necessary conditions to encourage innovation within an organization, we must focus on more than just the passive spread of ideas about an innovation.

1. The Innovation Process

This research focuses on the innovation process. Within the context of this dissertation, I have chosen to combine three definitions (Sørensen & Torfing, 2012; Hemphälä & Magnusson, 2012; Roberts, 2010) to characterize and define this process. This definition is an attempt to maintain clarity between invention and innovation, reinforce the emphasis on the process of innovation, and frame how innovation is applied throughout the remainder of this dissertation. Therefore, I define innovation as a social, interactive, and dynamic process—characterized by the exchange of knowledge and information—in which problems are defined and solutions are developed, refined, and implemented. This process consists of various stages that begin with an idea and end with an innovation. The unit of analysis for studying the innovation process, then, is the idea itself.

2. Stages of the Innovation Process

The following section describes the stages of the innovation process identified in the literature. Figure 3 provides a visual depiction of the entire innovation process, with further elaboration in the following paragraphs.
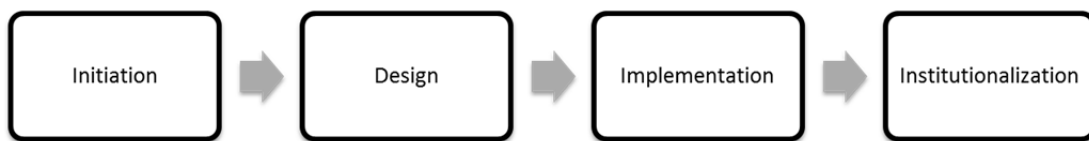
Figure 3.   The Innovation Process

a. *Initiation*

The initial stage of the innovation process, the period when a new idea is associated with a problem or need, is often referred to as initiation or creation (Roberts &

King, 1996; Roberts, 2010). "It is often said that innovation begins with an idea. To be more precise, it begins with an idea about an opportunity… in many instances, an opportunity is closely associated with problems" (Tang, 1998, p. 4). The identification of a solution to a problem, real or perceived, initiates the innovation process. Without a problem to solve, regardless of magnitude or difficulty, there is no need to innovate. March and Simon (1993) maintain that innovations form because of individuals' dissatisfaction with the status quo. This dissatisfaction stimulates people to search for improved conditions until a satisfactory result is found. The new product development literature calls these dissatisfied individuals "lead users" who perceive a problem and approach it with potential solutions (Lilien et al., 2002). It is important to recognize, however, that problem identification does not necessarily precede the creative ideation. Participants may in fact advocate for solutions before "highlighting the problems to which they become attached" (Kingdon & Thurber, 1984, p. 215).

As part of ideation, creativity is the first and most critical component necessary for individuals, organizations, and government agencies to innovate (Isaacson, Layne & Arquilla, 1999). Although it is implied that creativity and creativeness of an individual or organization is required for idea creation, importing ideas from other fields is also considered creative behavior (Van de Ven, 1986; Roberts & King, 1996; Reiter-Palmon & Illies, 2004; Paulus & Dzindolet, 2008). Ideas imported from other fields are adopted, refined, adapted, and modified by an individual or an organization for their specific uses based on how the solution can address organizational specific needs or problems. Appropriation, which is the process by which technology (or other artifacts) are reconfigured for organizational specific uses (Robertson, Swan, & Newell, 1996), innofusion (Fleck, Webster, & Williams 1990), and reinvention (Von Hippell, 1982) are all variations of importing ideas from other fields.

b. Design

The design stage follows initiation. During this stage, the raw materials of the initiation stage are converted into a more concrete, tangible form. The stage is characterized by dynamic, fluid, and iterative interactions in which ideas are refined,

prototyped, and tested in a variety of contexts and formats. It is during this stage that an idea is translated into a concrete or tangible form, such as a prototype (Roberts, 2010).

While innovation literature often lacks details of the design stage (de Lancer Julnes, 2015), the new product development literature is replete with examples of design in practice (Schneiderman, 1992; Brown & Eisenhardt, 1995; Sivadas & Dwyer, 2000; Lilien et al., 2002; Boland & Collopy, 2004; Ottenbacher & Harrington, 2007). Within this body of work, researchers describe the dynamic process of iteration that occurs where ideas are tested, refined, reinterpreted, repurposed, and prototyped until the final output of the process passes any number of internal checks and balances.

This transition from idea generation to product selection is one in which both the validity of the idea and the support network of the idea are critically important to garner management support (Kijkuit & van den Ende, 2007). The resultant output is ready for market and is primed for implementation (Veryzer, 1998).

c. *Implementation*

The third stage of the innovation process is implementation. Throughout the innovation literature, authors interchangeably use adoption and implementation to refer to the stage in the process when the new idea is put into practice. Adoption occurs when organizations develop or adopt an idea and have built the capacity to act on this idea (Julnes & Holzer, 2001). Adoption can be modeled as a series of interpersonal processes that affect individual behavior (Borgatti, Brass, & Halgin, 2014), but emphasizing individual behavior alone ignores the impact of internal and external influences on adoption behavior (Wejnert, 2002). However, the capacity to act or the decision to adopt an idea does not imply its actual use.

Implementation, on the other hand, delineates the transition from the design stage to the point at which the idea is introduced into practice. In other words, implementation is action resulting from an adoption decision. Implementation occurs "when an innovation is actually being used" (de Lancer Julnes, 2015, p. 15). This activity is not a singular action, but rather a "network building effort" focused on sustained, purposeful, and deliberate activity to implement an innovation (Van de Ven, 1986). Ideas that

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transition successfully from the implementation stage are described as innovations (Roberts, 2010). The completion of this stage of the innovation process requires the approval of gatekeepers that proclaim the new ideas "as invention, law, state, policy, or program" (Roberts, 2010, p. 3).

d. Institutionalization

The final stage of the innovation process is institutionalization. It signals the innovation has become a matter of accepted practice (Roberts, 2010). Institutionalization is "a process through which an organization assimilates an innovation into its structure" (Miles, Eckholm, & Vandenberghe, 1987, p. 34), and includes "the maintenance, disruption and change of institutions" (Vargo, Wieland, & Akaka, 2015, p. 1). That is, the way in which an organization operates or conducts business using the innovation—whether an artifact, policy, or process—is a matter of habit and the incorporation of the innovation is now second nature. Researchers often refer to this final stage of the innovation process as routinization (Greenhalgh et al., 2004), but the use of the word "institutionalization" provides a stronger, more concrete conceptual mapping than does the act of making something habitual or routine.

C.   ENTREPRENEURSHIP

Having now discussed innovation and the innovation process, we now turn to the second focus of the literature review—entrepreneurship. Entrepreneurship has long been in existence as a core concept in business and government and studies of entrepreneurs range from economics to management and include both the public and private sectors (Roberts, 2010). Entrepreneurship, the system of knowledge and principled beliefs about "entrepreneurialism" (Chell, 2007), owes its modern roots to the views of Joseph Schumpeter. Schumpeter believed that an entrepreneur was a person who destroyed the existing economic order through the introduction of new goods and services, the creation of new organizations, or by exploiting raw materials in new and different ways (Bygrave & Hofer, 1991). Bygrave and Hofer (1991, p. 14) expanded the definition of Schumpeter's view of an entrepreneur to "a person who perceives an opportunity and creates an organization to pursue it." Extending the view on entrepreneur further, the

literature on entrepreneurship has acknowledged that entrepreneurial activity may occur in a collective fashion where an entrepreneurial team of individuals acts together to craft new ideas and implement them within an organization (Cooper & Daily, 1996; Roberts, 1992; Roberts & King, 1996; Clarysse & Moray, 2004; Cooney, 2005). Within the team, an individual may be identified further still as the lead entrepreneur (Ensley, Carland, & Carland, 2000).

Despite the widespread study of entrepreneurship, the definition of entrepreneurship has been criticized as being narrowly defined and overly focused on the creation of organizations (Zerbinati & Souitaris, 2005). Moreover, the nature of the entrepreneur and the entrepreneurial process is not universally held (Chell, 2007) and much like innovation, there is no one agreed upon definition for either an entrepreneur or the entrepreneurial process (Spencer, Kirchoff, & White, 2008).

To reconcile the definitional issues of entrepreneurship (in this case, corporate entrepreneurship), Sharma and Chrisman (2007) focused their review of the field and found that nearly 79% of entrepreneurship studies were defined by the characteristics of entrepreneurship (e.g., innovation, growth, etc.) as opposed to the outcomes of entrepreneurship (e.g., creation of value). From their study, they concluded that entrepreneurship "encompasses acts of organizational creation, renewal, or innovation that occur within or outside an existing organization" and that entrepreneurs are "individuals, or groups of individuals, acting independently …who create new organizations, or instigate renewal or innovation within an existing organization" (Sharma & Chrisman, 2007, p. 18).

Within the literature, there is also a distinction between an entrepreneur, an entrepreneurial team, and an entrepreneurial network. Although entrepreneurship is usually studied in the context of the private sector, entrepreneurship is also a phenomenon of interest in the public sector. Numerous studies focus on entrepreneurial activity within the public sector (Roberts, 1992; Heinonen, 2001; Zerbinati & Souitaris, 2005; Roberts, 2007; Roberts, 2010; Westrup, 2013). Public entrepreneurship has been defined as "the generation of a novel or new idea and the design and implementation of the new idea into public sector practice" (Roberts, 1992, p. 55). It is a "process of

becoming, not a static phenomenon" (Heinonen, 2001, p. 223). Within an organization, entrepreneurship has been viewed in a similar fashion as project management as both the entrepreneurial process and project management are concerned with implementing ideas and responding to uncertainty in an environment (Westrup, 2013). Entrepreneurs create new, innovative organizations, design new ideas and implement them, and develop new technologies. The entrepreneurial process (and the activities contained therein) plays an active role in understanding the dynamics of innovation (Hagedoorn, 1996).

1. Entrepreneurship or Innovation?

Within the literature on entrepreneurship and innovation, a common issue that readers encounter is the use of ambiguous terms to describe the actions and activities of an individual (an entrepreneur) or group of individuals (entrepreneurial team)—collectively known as entrepreneurship—to move an idea through a process from creation to acceptance within an organization (i.e., innovation). To clarify the relationship between these two processes, we must look at the unit of analysis within each process and clarify the interaction between them.

Chell (2007) posits that to behave entrepreneurially is to engage in a process, embedded within a socio-economic context, to create value. The entrepreneurial process involves "all the functions, activities, and actions associated with perceiving opportunities" (Bygrave, 1997, p. 2). Ideas are not the defining characteristics of entrepreneurship, but rather it is the development of ideas and the implementation of these ideas in the entrepreneurial process that is key (Bygrave, 1997). A conceptual model that integrates entrepreneurship and innovation (Roberts & King, 1996) can be seen in Figure 4.

Interactive Processes of Entrepreneurship and Innovation

Entrepreneurial Process

Innovation Process:

Initiation ------> Design ------> Implementation ----> Institutionalization

(New Idea)   (Prototype)   (Innovation)   (Accepted Practice)

Entrepreneurial Process
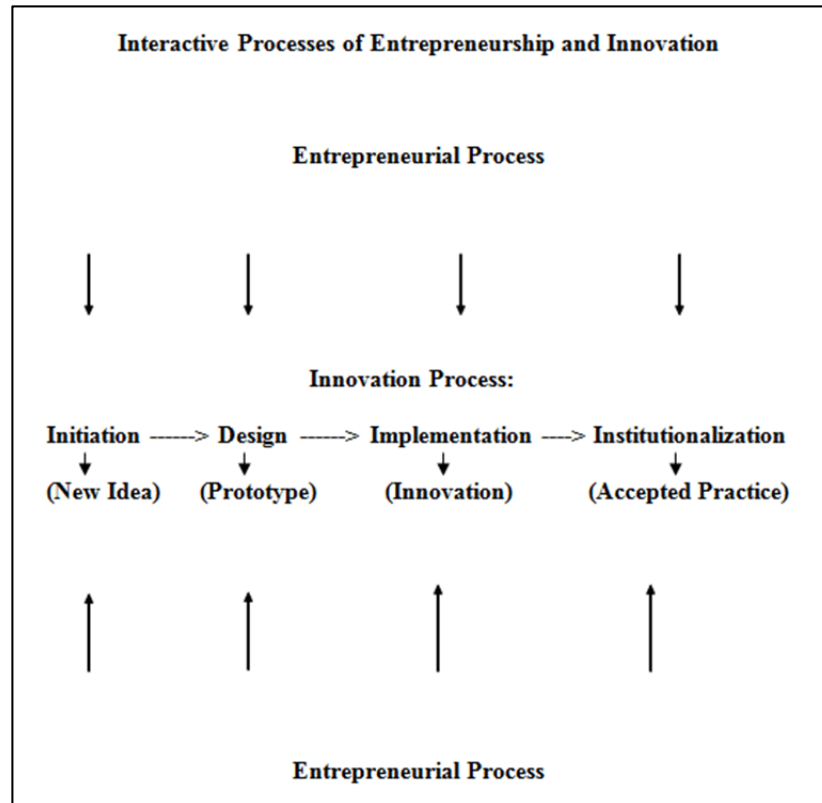
Figure 4.   Integration of Entrepreneurship and Innovation.
Source: Roberts and King (1996).

To understand this framework, it is important to highlight the differences in units of analysis between the entrepreneurial process and the innovation process. As represented by the vertical dimension in Figure 4, the unit of analysis of the entrepreneurial process is the entrepreneur's activities and actions, as well as the activities and actions of the entrepreneur's support network. The entrepreneur's challenge is to give shape and form to new ideas and manage the idea's transitions through idea generation, design, and implementation. For example, an entrepreneur identifies a problem and imports a solution from another context or creates a new solution during the initiation stage. Often, innovation literature treats the actions and activities of an entrepreneur or an entrepreneurial team as "innovation," but the unit of analysis in question is best understood as the activity taken to move that idea into accepted practice.

The unit of analysis for the innovation process, however, is the idea itself. Along the horizontal dimension of the Roberts and King model, the innovation process "tracks

the various manifestations of the new idea (idea, prototype, innovation) as it moves through the processes of initiation, design, and implementation" (Roberts, 2010, p. 4). As an idea evolves over time, the changes to the idea can be tracked in the innovation process. The vertical dimension, however, tracks the entrepreneur's actions and activities (securing resourcing, communicating the idea, engaging with target audiences, etc.) to ensure the idea is moved through the innovation process. Thus, the entrepreneur or entrepreneurs are the drivers of the new idea as it winds its way through the twists and turns of the innovation process. The two processes interact with each other; neither exists in isolation.

2. A Network Perspective of Entrepreneurship and Innovation

With the different units of analysis of the entrepreneurship and innovation processes in mind, it is imperative that we adopt a relational perspective with which to study the interaction of these two interconnected, but distinct processes. A substantialist view of innovation and entrepreneurship decomposes the processes into the raw components and attempts to understand the effect of these components on the outcomes of the process. A relational view, however, treats the two interconnected processes as parts of a complex adaptive system where the study of the processes must consider the embedded nature of these processes. Entrepreneurship and innovation do not exist in isolation, but rather they are embedded within networks of relationships between individuals and organizations.

In the literature, we find various studies that have incorporated a relational perspective to explain or understand the role networks of individuals and organizations play in supporting innovation. While the literature often calls this activity the "innovation process," it is best understood as the entrepreneurial process where entrepreneurs and entrepreneurial networks move an idea through time to gain acceptance.

Innovation and entrepreneurship are social processes that are best understood as dynamic in nature (Knight, 1967; Van de Ven, 1986). The processes are enabled and embedded within "networks, partnerships, and other interactions [that] can accommodate and implement new and bold ideas in ways that reinvigorate public policies and services"

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(Eggers & Singh, 2009 as summarized by Sorenson & Torfing, 2012, p. 1). Social networks facilitate the transfer of ideas between individuals and organizations (Tushman, 1977; Conway, 1995; Borgatti & Cross, 2003; Burt, 2004; Fritsch & Kauffeld-Monz, 2010; Dahlander & Frederiksen, 2012. Whereas an idea may originate in one context, the idea is brought by individuals (entrepreneurs) into another context and the ideas are communicated through the formal and informal networks (Krackhardt & Hanson, 1993).

Formal communication channels within an organization are often studied to understand how ideas move through time. Once an idea is formed, collective action around these ideas is rallied (Kijkuit & Van den Ende, 2007), and social influences impact and drive the creative process (Perry-Smith & Shally, 2003; Cockayne, 2004; Kijkuit & Van den Ende, 2007; Paulus & Dzindolet, 2008; Sosa, 2010). Innovation research has focused on understanding how Broadway musicals are developed (Uzzi & Spiro, 2005), how network structure fosters creativity (Fleming & Marx, 2006), and how network structure affects regional innovation (Fleming et al., 2007).

Additional research has been conducted to understand the structural properties of networks and how the structure of networks contributes to collaboration and creativity, affects the rate and type of innovation diffusion (Abrahamson & Rosenkopf, 1997; Young, 2002), and how the structure determines "innovativeness" (Bell, 2005). Lazer and Friedman (2007) have explored the structure of communication networks and the effect on system level performance and collective problem. Researchers have found that interpersonal, boundary-spanning networks allow information to be communicated across borders—a critical component of innovation diffusion (Rogers, 2010).

Boundary spanning individuals (Tushman, 1977; Conway, 1995; Burt, 2004; Fritsch & Kauffeld-Monz, 2010) are viewed as playing an important role in knowledge exchange. Dahlander and Frederiksen (2012) have examined user position in networks to understand the effect on innovative behavior, and perhaps unsurprisingly, they have found that individuals who span multiple communities have the greatest potential for innovation. More specifically, researchers have looked at individual "position" within networks to determine if structural holes, defined as "a relationship of non-redundancy

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between two contacts" (Burt, 2009, p. 3), is more critical than weak, infrequent ties (Granovetter, 1973) in communicating ideas.

Each of these studies generate propositions to explain the success of innovation, but the activities described within these studies focuses on the activity of individuals and organizations in moving ideas from concept to implementation. In other words, the unit of analysis is the *entrepreneurial activity*, not the *idea* itself. While the findings of these studies are no doubt important, the mislabeling of the entrepreneurial activity to gain support for and acceptance of an idea rather as "innovation" or "innovativeness" has caused a significant amount of confusion within the literature.

Nevertheless, it is clear the entrepreneurship and innovation are network-building efforts (Van de Ven, 1986), and the view of the sole entrepreneur moving an idea through an organization, while evoking heroic images, is far from reality. Entrepreneurs—either individually or a team of individuals—engage others, over time, to garner support and move ideas through time. Their actions occur embedded within a network of ties and are, by definition, collaborative in nature.

Collaboration is "the process of shared creation: two or more individuals with complementary skills interacting to create a shared understanding that none had previously possessed or could have come to on their own. It is a purposive relationship based on a desire or need to solve a problem, create, or discover something within a set of constraints" (Schrage, 1991, as cited in McLellan, 1997, p. 186). Where innovation occurs, it is done largely as part of a larger community (Von Hippel, 2005). Innovation, and entrepreneurial activity, does not exist in isolation. The innovation and entrepreneurial processes are collective in nature (Van de Ven, 1986).

3. Management of Ideas

I now turn to a discussion of the management of ideas within the entrepreneurial and innovation processes. While ideas are at the heart of the innovation process, the role that entrepreneurs and organizational management play in managing the entrepreneurial activities to move an idea through the innovation process are critically important as well.

Previous research has highlighted the critical role that managers play in facilitating and coordinating entrepreneurial activities (Van de Ven, 1986; Mone, McKinley, & Barker, 1998; Abrahamson, 1991; Grady, 1992). Van de Ven's work on idea management (1986) forms the foundation upon which a significant amount of the literature on idea management is based. Van de Ven suggests that managers within organizations face four big problems related to innovation: (1) Managers are faced with a "human problem of managing attention" (2) Converting new ideas into "good currency" is largely a process problem, (3) Managing part-whole relationships is a "structural problem" within an organization, and (4) Institutional leadership faces a "strategic problem" with regard to managing innovation. Each of these problems is now described in further detail.

According to Van de Ven (1986), people and organizations are more likely to protect existing practices rather than develop "new ideas." As organizations become more successful and established, "the more difficult it is to trigger peoples' action to pay attention to new ideas" (Van de Ven, 1986, p. 3). While new ideas may emerge from individuals (i.e., champions), innovation is a "collective achievement" that requires management to ensure that ideas are translated into innovations within an organization. As innovation requires multiple "functions, resources, and disciplines" to move an idea into practice, managers must play a role in converting individual action into a whole of organization "innovation effort." Finally, as innovations may alter or adjust existing organizational arrangements, managers play a critical role in ensuring that the "infrastructure [of an organization] are conducive to innovation" (Van de Ven, 1986, p. 4).

Van de Ven's work suggests that successful innovation is due to the efforts of management and managers within an organization, but the role of the entrepreneur in managing ideas through the process is less clear. Schroeder et al. (1989) expanded Van de Ven's earlier views of the role of management by studying several case studies and making observations about new ideas from these studies to observe that innovation is often stimulated by a shock to an organization, and ideas often proliferate or splinter into several different ideas during the innovation process. Along the innovation journey, ideas

face unpredictable setbacks and changes along the way and organizational structures and processes are often restructured to support the innovation process. Finally, several levels of management are involved in decision making along the innovation journey. Alexe, Alexe, and Militaru (2014, p. 1) extend the view on idea management by arguing that idea management is the result of deliberate actions on the part of management to "bring order in the set of ideas and to create a transparent and effective mode in attracting and management of these ideas." Additional research has suggested that managers merely need to turn to technical solutions and decision support tools to assist with the idea generation process (Flynn, Dooley, O'sullivan, & Cormican, 2003; Du Preez & Louw, 2008) and facilitate innovative activity (Malone, Laubacher, & Dellarocas, 2009).

If the literature on idea management is accurate, the role entrepreneurs play is an important, albeit, minor, one. Entrepreneurs identify solutions to problems, import potential solutions into organizations, and enable ideas to take on a life of its own by relying on well-defined management processes and structures to shepherd an idea through the innovation process. These processes extend from the private to the public sector with managers being viewed as the "conveners," "mediators," and "catalysts" of innovation within the public sector as well (Sørenson & Torfing, 2012). This view, however, seems overly simplistic in nature and fails to address the complexities of idea management as it only addresses the role of management and not the role of the entrepreneur. Decades of research into innovation management has failed to provide "clear and consistent findings or advice for managers" as innovation management is contingent on "a range of factors… such as uncertainty and complexity… that influence organizational structure and management processes for innovation" (Tidd, 2001, p. 169).

To address this perceived lack of clear and consistent findings, researchers have shifted focus from the manager within an organization to the networks in which individuals are embedded. Björk and Magnusson (2009) investigated individual performance for idea generation with respect to the social networks in the organization in which the idea generators were embedded. Their research identified that high-quality ideas from well-connected groups perform worse than individuals with fewer social connections within an organization. Thus, idea management is based on a "multitude of

factors," one of which relates to the social networks of individual actors, and is not simply due to formalized management processes.

Thus, I have identified that the literature often confounds the innovation and entrepreneurial processes by focusing on the activities of entrepreneurs in moving ideas through the innovation process and labeling this activity as "innovation." Furthermore, we see that the literature tends to address only one aspect of the management of ideas— namely the management of ideas from the formal organizational management perspective—and has discounted or failed to address the management of ideas from an entrepreneur's perspective. As such, I now turn to three theories that can help frame an approach to studying entrepreneurship and innovation, not from the perspective of the formal management within an organization at an aggregated level of analysis (macro), but rather an approach that takes the entrepreneur's perspective, at the idea level (micro), in managing the meaning of an idea through time.

4. Interpretive Governance and the Management of Meaning

Interpretive governance theory provides a framework for understanding the actions of an entrepreneur, embedded in a network of relations within an organization, to move an idea into practice. Interpretive governance theory (Bevir & Rhodes, 2006; Bevir & Richards, 2009), adopted from the literature on governance in British politics, provides a framework with which to explore innovation research. Using an interpretive governance theory approach for innovation, we shift focus from the formal management of ideas within an organization to the management of ideas by "individual actors and the meanings that they are constructing and acting upon" (Osborne & Browne, 2013, p. 311). In other words, innovation and idea management is best understood by studying the actions and communications of entrepreneurs.

Entrepreneurs create meaning through action. By focusing "on the social construction of a practice through the ability of individuals to create, and act on, meanings; is to unpack a practice in terms of the disparate and contingent beliefs and actions of individuals" (Bevir & Rhodes, 2006, p. 77). This theory "implies that network governance arises from the bottom-up. Any pattern of governance is a product of diverse

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practices made up of multiple individuals acting on all sorts of conflicting beliefs which they have reached against the background of several traditions and in response to varied dilemmas" (Bevir & Rhodes, 2006, Chapter 4). The interaction between entrepreneurs and the networks in which they are embedded "provide rules, norms, routines, cognitive scripts, and discourses that structure the actions of the social and political actors and create particular patterns of interaction" (Sørensen & Torfing, 2011, p. 860). Thus, innovation—in the eyes of interpretive governance theory—focuses on both the actions and communications of individuals.

Entrepreneurs carefully and deliberately manage the meanings of the ideas they construct and act upon by communicating and framing ideas during the innovation process. The construction of meaning and narratives during the communication process (Pearce & Cronen, 1980) shapes the innovation process (Bartel & Garud, 2009) and provides a more holistic, granular view of the entrepreneurial activities required to manage ideas over time.

D.   SUMMARY

I have examined two processes—innovation and entrepreneurship—and highlighted the need to explore and understand the interaction between them in the context of public sector innovation. The literature on innovation and entrepreneurship spans many decades. Innovation studies have provided a foundation upon which many studies, to include this one, are based. While the unit of analysis issue is pervasive in the literature, innovation has been researched for decades to understand how, and under what conditions, solutions to problems are identified, selected, and managed within organizations. Entrepreneurship studies have focused on the characteristics of the entrepreneur, the entrepreneur's activities to move an idea through innovation process, and the relationships of entrepreneurs embedded within organizations and networks to understand the roles individuals play in moving ideas into accepted practice.

As the literature often confounds entrepreneurship and innovation, I turned to an integrated process model to clearly delineate the two units of analysis. The Roberts and King (1996) model integrates the two processes and invites further study on how the two

processes are interconnected. This model delineates the units of analysis for innovation and entrepreneurship and clarifies the interaction between the two processes.

While the literature has acknowledged the embeddedness of entrepreneurs within networks and has identified the critical role that management plays in ensuring ideas become innovations, the overwhelming emphasis on formal management processes and technical systems to solve management issues has underplayed the importance of the management of ideas by entrepreneurs. Furthermore, the case studies used to generate observations about idea management study ideas at a macro level (i.e., at the organizational level) rather than at a micro level (i.e., at the level of the entrepreneur).

As such, new theoretical frameworks for understanding how and why entrepreneurs communicate and manage ideas must be adopted to explore the management of meaning in the communication of ideas at a more granular level. In this chapter, I introduced interpretive governance theory and the coordinated management of meaning as two theories that should guide this exploration.

Building on the knowledge of the entrepreneurial and innovation processes outlined in this review, the research questions for this dissertation are designed to explore how ideas develop and move through the innovation process over time and how entrepreneurs affect the ideas by managing their meaning. These two questions are probed with the perspective that entrepreneurs are embedded within networks in their respective organizations, and this embeddedness both shapes and influences how ideas are communicated and the interaction between entrepreneurs and varying audiences.

Innovating in the DOD is best understood by studying the interaction between the innovation and entrepreneurial processes. While innovation is often championed as the answer to a variety of problems the DOD faces, understanding how the entrepreneurial and innovation processes within the Department are interconnected remains elusive. In an organization where guidance and direction are provided from the top down, and ideas and new tactics, techniques, and procedures are developed from the bottom up, how the DOD effectively can organize, foster, and encourage innovation remains unanswered.

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III. STUDY DESIGN AND METHODS

A.   INTRODUCTION

This study conducts exploratory research on the innovation and entrepreneurial processes within the DOD to gain an understanding of how ideas evolve and how the entrepreneur manages the ideas as they move through time.

In Chapter II, I described how the current body of literature tends to emphasize singular stages of the innovation process (such as diffusion) rather than treating innovation as a complex, multi-staged process that includes initiation, design, implementation, and institutionalization. In summarizing the literature on entrepreneurship, I note how the innovation and entrepreneurship processes are often confounded, which makes interpretation of research difficult. Finding a model that integrates both innovation and entrepreneurship enables the exploration of two related and interconnected phenomena.

In this research, I have adopted the integrated model from Roberts and King (1996) to study the interconnections between innovation and entrepreneurship. Innovation—a social, interactive, and dynamic process, characterized by the exchange of knowledge and information, in which problems are defined and solutions are developed, refined, and implemented, and entrepreneurship—acts of "individuals, or groups of individuals…who create new organizations, or instigate renewal or innovation within an existing organization" (Sharma & Chrisman, 2007, p. 17)—define this study.

To address the **research questions** of this study— "*How do ideas develop and evolve over time as they move through the innovation process?*" and "*How do entrepreneurs manage the meaning of an idea as it evolves over time?*"—I use a mixed methods research strategy to support its exploratory nature. This chapter reviews the study design and methodology in depth. I lay out the overall research strategy then summarize the data collection, management, and analysis techniques I employ. I conclude the chapter with a discussion of the study's methodological and analytic limitations.

B.   RESEARCH STRATEGY

In Chapter I, I introduced the overarching research strategy figure (Figure 1) to help guide the discussion and introduce the reader to the overarching strategy. In this chapter, Figure 5 is used to orient the reader and to highlight the interconnections and visual map of this research which are discussed in greater detail in the following sections.
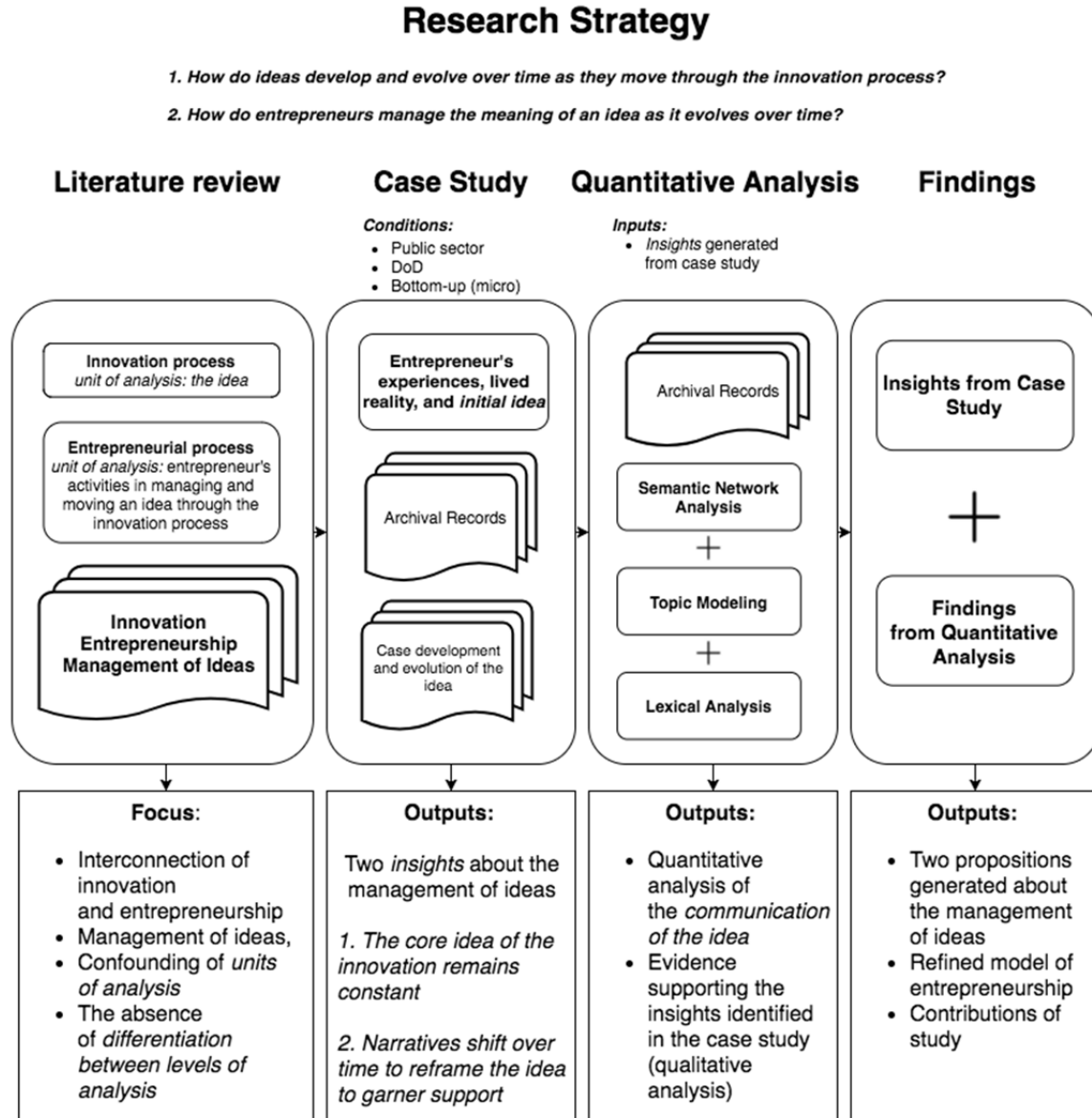
Figure 5.   Research Strategy Revisited – A Visual Map of the Inquiring System

As this research is focused on theory building rather than theory testing, I chose a mixed-methods approach—blending a case study with a quantitative analysis—as the most appropriate strategy to address the research questions. Given the need to understand a phenomenon of interest in its natural setting with no manipulation or controls, I deemed a case study design to be the most appropriate form of inquiry.

Although the case study could only generate insights into the specific case at hand, I was interested in applying additional analytic rigor into the analysis of the case observations using various lexical analysis methods to further probe the observations. This quantitative analysis was meant to enhance the observations from the case study and reinforce or refute the insights based on a lexical analysis of the archival records. I employed quantitative methods to conduct a longitudinal semantic network analysis, topic modeling, and lexical analysis to explore the two insights on how the entrepreneur communicates to various audiences and stakeholder to manage the idea's meaning over time. The results of this analysis did in fact reinforce the insights obtained from my case study and led to the generation of two propositions about the management of ideas in the innovation process.

The blending of a case study with semantic network and lexical analysis is like the design used by Baker and Faulkner (1993), which blended archival data analysis, and quantitative social network analysis to study innovation. The characteristics of the research strategy—a case study, with both qualitative and quantitative methods—are described in further detail in the following sections.

1.   A Case Study

Qualitative methods have formed the foundation upon which much of scientific inquiry is based, and only in the last hundred or so years did it begin to be replaced by quantitative methods (Ritchie, Lewis, Nicholls, & Ormston, 2013). The resurgence in qualitative research as a viable methodological choice is rooted in a shift of philosophical views. In the first chapter of this dissertation, I provided a comparison between substantialism and relationalism. The epistemology and ontology of relationalism influences this research.

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In qualitative research, researchers incorporate frameworks that address the perspective of the researcher, provide flexibility in the choice of research designs, enable broader categories and types of data gathered, enable different analytic approaches to be used, and enable the generation of theory (Ritchie et al., 2013). Qualitative research offers several advantages (Corbin & Strauss, 2014):

- exploration of inner experience

- exploration of meaning formation and transformation

- exploration of underdeveloped areas of research

- discovery of variables to be used in quantitative research

- study of a phenomena of interest in a holistic and comprehensive manner

For this study, qualitative methods enabled an in-depth exploration of the innovation process from an insider's perspective, incorporated a variety of data sources obtained over a long period, and allowed for an exploration of the entrepreneurial and innovation processes within a specific organizational context.

The case study presented enabled me to explore the evolution of a new idea within the DOD in great depth. Longitudinal case studies often appear in the innovation literature (Burkhardt & Brass, 1990; Cockayne, 2004) as they offer the ability to conduct an in-depth exploration of the innovation process in its natural settings over time. Data are collected using multiple methods and the results of the data analysis are dependent on the integrative powers of the researcher (Benbasat, Goldstein, & Mead, 1987; Creswell, 2013). The data I collected and analyzed offer a far more nuanced, detailed, over-time exploration of innovation in a natural setting than would have been possible in a controlled quantitative study.

Case study research also allowed me to explore the complexity of the innovation process within an organization. This type of design is especially useful when the boundaries between phenomenon and context are not evident (Yin, 2013) as it was in this case. While this style of research has drawn criticism for its lack of generalizability of the results found, questionable objectivity, and the lack of numerical representation, it is a

powerful strategy when trying to understand complex inter-relationships and develop concepts. Table 2 summarizes the strengths and limitations of case study research.

Table 2. Strengths and Limitations of Case Study Research.
Adapted from Hodkinson and Hodkinson (2001).

Strengths	Limitations
Allow for an understanding of complex inter-relationships	Difficult to easily analyze
"Are grounded in lived reality"	Large-scale studies are expensive
"Facilitate the exploration of the unexpected and unusual"	"Complexity examined is difficult to represent simply"
"Can enable research to focus on the significance of the idiosyncratic"	"Do not lend themselves to numerical representation"
"Can show the processes involved in causal relationships"	"Not generalizable in the conventional sense"
"Can facilitate rich conceptual/theoretical development"	Strongest when researcher expertise and intuition are maximized, but "objectivity" is questioned
	"Easy to dismiss by those who do not like the messages they contain"

While the limitations of case studies are noted, the choice of using a case study enabled me to blend multiple methods of data collection and analysis to provide a rich, detailed description of the complex inner workings of the innovation process, especially one that emerged from the bottom of the organization and pushed outward and upward throughout the bureaucracy. Such a case as this can reveal insights that are likely to be common in other cases (Yin, 2013).

In addition to addressing problems with the innovation process which may be relevant to other large public organizations, this multi-year study offers a unique

historical accounting of the innovation process within of a military organization that offers value to military practitioners and academics alike.

2.   Quantitative Methods

In order to probe the case study insights further, I applied three separate, but related text analysis procedures on the archival records. These three procedures— semantic network analysis, topic modeling, and lexical analysis—along with the requisite text pre-processing are described in greater detail in the following sections.

a.   *Text Pre-processing*

Most text analysis programs include some form of text processing and cleaning and all require text documents to be prepared prior to analysis. As the pre-processors can vary in the changes made to different documents, it is important to use a single text processing method as the input to a text analytic tool when comparing results from different text analysis procedures. All the text pre-processing for this study was conducted in AutoMap to maintain consistency across the text analysis procedures.

b.   *Semantic Network Analysis*

In addition to using a case study, this research incorporates an exploratory semantic network analysis. Semantic network analysis, also known as Network Text Analytics (NTA), is an analytic approach that treats words and phrases in text documents as nodes and their proximity to each other as relationships (Popping, 2003). This technique can provide insights into the language used in speeches, documents, and other written form, and has even been used to detect covert networks in texts (Diesner & Carley, 2004). NTA was conducted on the archival records used to communicate the new idea. These documents, when analyzed using NTA, provide insights into the semantic changes in the communication of the idea (i.e., the words used to describe the new idea by the entrepreneurial team) as it moved through time. The analytic procedures used in semantic network analysis include a variety of techniques and measures to identify terms of significance and describe their significance using a defined typology.

Within the archival records, the semantics describing the new idea are modeled as networks and analyzed using social network analysis. Propositions drawn from this analysis support our understanding of the communication and description of an idea over time and provide insights into how the entrepreneur managed the communication of the idea over time.

While NTA allows for robust visualizations and analyses of text documents, it is not without limitations. NTA, like all lexical analysis procedures, are influenced by the choices made by a researcher to define the components of a network. For example, semantic network analysis treats words as nodes and the proximity of words as edges in a graph. A researcher defines how "close" a word must be to another word to be defined as a connection (i.e., adjacent, within the same sentence, within the same paragraph). Thus, it is important to not make over-reaching claims about the structural properties of documents as the structure is defined by the researcher.

c. *Topic Modeling*

In addition to semantic network analysis, I have included topic modeling as an approach for conducting text analysis. Topic modeling provides a mechanism for organizing, summarizing, and analyzing large volumes of electronic archives. Whereas semantic network analysis treats the proximity of words within sentence as edges and the appearance of words as nodes, topic modeling begins with the presumption that documents exhibit multiple topics. Topic models are based on the presumption that "documents are mixtures of topics, where a topic is a probability distribution over words" (Steyvers & Griffiths, 2007, p. 2). Topic modeling allows for the identification of themes that pervade a corpus of text, facilitates the annotation of themes, and allows for a means of comparing single documents to a corpus to better understand their relationship.

In practice, topic modeling assumes that a document exhibits multiple topics and these topics are based on a statistical distribution across a range of documents. Thus, given a corpus of documents, topics are generated, weighted, and scored. While this approach provides for a rapid visualization of topics within a document, researchers must be careful to not "read their results into the data." As such, it is recommended that topic

modeling is used as a queuing mechanism for additional analysis and is not sufficient as a stand-alone procedure. For the topic modeling conducted in this study, I have chosen to use the Topic Modeling Tool (TMT) by Arun Balagopalan, a Java based graphical user interface based topic modeling tool built on top of MALLET[6] (McCallum, 2002).

d. *Lexical Analysis*

Finally, I have chosen to include additional lexical analysis approaches in addition to the semantic network analysis and topic modeling. As I wanted to explore the changes in how the idea was communicated over time (or lack of change), I have incorporated document similarity comparison techniques using dendrograms, Voronoi diagrams, and clustering algorithms to compare the similarity of the documents within the corpus. The lexical analysis conducted in this study was enabled by the Lexos tool (Kleinman, LeBlanc, & Drout, 2016).[7] Lexos is a suite of tools that allow for the pre-processing, analysis, and visualization of text in a single web based application. Lexos was used to generate the dendrograms, Voronoi diagrams, and clustering statistics presented in Chapter V. It is important to note, document similarity comparisons are susceptible to a corpus with documents that vary greatly in length. Thus, researchers must design analysis in such a way as to minimize the effects from very large documents in comparison to smaller documents such as the use of term frequency-inverse document frequency (TF-IDF) comparisons, or adopt techniques that compare only the top N most frequently occurring words within a document to each other.

C.   STUDY DESIGN

Having now discussed the research strategy chosen, I turn to detail the specifics of the study's design to provide a roadmap of activities from the beginning stages of the research effort to its final stages. The steps include:

- Initial activities

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[6] MALLET remains under active development. More information can be obtained from the UMass website at http://mallet.cs.umass.edu.

[7] The latest stable release of Lexos is available for download at https://github.com/WheatonCS/Lexos/tree/masterSummer2015.

- Literature review

- Development of a conceptual model of entrepreneurship and innovation based on the literature review

- Data collection for case development, data structuring and text analysis

- Integrative analysis and discussion

1.   Initial Activities

At the onset of this study (which began to take form around 2012), I developed an initial proposed area of research that focused on formal and informal social networks and the development of a new idea and artifact. My initial proposal was influenced by my desire to better understand and document an experience I had directly observed and participated in while trying to move from an applied understanding of innovation to a more conceptual and theoretical framework. I co-authored a preliminary study on bottom-up innovation in the DOD while the innovation development process was still underway (Roberts & Longley, 2011; Roberts & Longley, 2013).

2.   Development of a Conceptual Model of Innovation, Entrepreneurship, and Networks

From the literature review, I revisited the development of a conceptual model that blended innovation and entrepreneurship. This initial model served as a "mental primer" that I used when approaching the data collection, synthesis, and analysis and guided the development of the framework for this study. This conceptual model was based on the entrepreneurship and innovation framework of Roberts and King (1996) and incorporated a network perspective with which to view the inter-relationship between the two processes captured in the model. As the unit of analysis in the innovation process is the idea, the evolution of the new idea is detailed in the case study. For the entrepreneurial process, the unit of analysis is the activity of the entrepreneur and his team, and Chapter V focuses on the entrepreneurial activities and efforts to manage the meaning of the idea and gain acceptance of the idea within the organization.

3.   Data Collection, Structuring, and Analysis

For the past seven years, I have a maintained project management data set documenting the new idea and entrepreneurial activity surrounding the efforts to move the idea through the innovation process. I collected these data during the day-to-day management and oversight of the development of the new idea. At the initiation of the idea, I did not deliberately plan to collect data for the purposes of studying innovation—I simply collected and retained the project data to support project management. Eventually, it became clear that the archived data could be used to conduct a longitudinal study of innovation. Furthermore, because the data included geo-temporal, social, and descriptive information about the new idea from inception to conclusion, I realized I had a unique data set with which to study the innovation process.

Where I found gaps in the project's historical data, I contacted seven individuals who had connections to or were actively managing aspects of the project to fill in missing details. Thus, I updated my archived data with their observations into one dataset. The challenge, however, became one of data processing and interpretation. This study includes several data structuring and processing strategies employed to provide a robust description and recollection of the events surrounding the case. These strategies, which I elucidate below, include both the use of archival data and participant observations.

a.   *Primary Source Material and Documentary Evidence*

The case study incorporates a variety of data sources to ensure an accurate and detailed recollection of the events. Data sources include white papers, project briefs, project status documents, travel documents, meeting minutes, news articles, and email communications.[8]

These records are used in several ways. First, the records are used to ensure an accurate recollection of events during the case study. As this study was a lived reality for me from 2009 to 2012, I used the material to confirm my recollection of events and to

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[8] The details of the amount of data, specific binning, and use in the analysis is described in greater detail in "Data Management' in a section that follows in this chapter.

ensure an accurate retelling of the case. Secondly, the records enable me to extract and structure data to conduct a quantitative analysis of the communication of the idea to augment the case study inquiry. This quantitative analysis is done to highlight the changes (or lack thereof) in the communication of the idea over time.

b. *Participant Observation*

The case study is built upon my recollections of the innovation process as a participant-observer. To establish timelines and accurate recollections, I had informal discussions with seven other individuals directly involved in the case to ensure I presented an accurate representation of the events that transpired. To enhance the accuracy and minimize the effects of details being lost or forgotten, I expanded the case study from a previously published work (Roberts & Longley, 2013) and included nearly four years of additional data. Additionally, I crosschecked key events, people, and organizations with the archival data to ensure proper sequencing of events. I describe how I extracted the key individuals, organizations, and events from the archival data in the following sections.

This dissertation features a unique factor that differentiates it from other innovation and entrepreneurship studies. First, my role in this study is both participant (lead entrepreneur) and observer (researcher). The case study takes place over several years in which I was both the lead entrepreneur in the innovation process through the initiation and design stages of the innovation process. After transitioning out of NPS into a unit within the Marine Corps in 2012, I became an outside observer of the innovation process. Although I did not know it at the time, I was observing the beginnings of the implementation stage. The dual role of participant and observer provided a unique blending of two different viewpoints helped me minimize the theoretical tensions between the emic and etic perspectives in qualitative research (Godina & McCoy, 2000). This blended insider-outsider view of the innovation process in the DOD setting, and the robust data set, together provide a unique exploration of the innovation process.

c.   *Data Management*

Due to the large volume of data associated with the archival records for this study, it became clear early in the data collection process that a full data management suite of tools would be required to collect, process, and prepare the data for analysis. To accomplish these tasks, I used the Mac database tool called DEVONthink Pro Office (DPO). DPO enabled several data management tasks, to include data cleaning, de-duplication, file storage and retrieval, Optical Character Recognition (OCR) processing, and enhanced Boolean search. This multi-purpose tool enabled me to import files into the application, generate OCR documents (if they were not already in a searchable format), and group material into an orderly and searchable index.

A key feature of DPO is the ability to streamline data processing using the robust file index and search features of the application. This software tool, along with various cloud backup options, ensured the data used in this study was both free from corruption and readily available.[9]

To highlight the sheer volume of data collected and managed in this study, Table 3 summarizes the file types, descriptions, and file counts used in the analysis of this study.

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[9] As a side note, I used DPO to manage my literature review documents and could cross-reference and search for keywords, topics, and citations with relative ease. At last count, DPO had more than 121 articles in the literature review section of the database. This was the processed number of articles after culling the number down from more than 500. More information on DPO and its capabilities are available from the software vendor online at http://www.devontechnologies.com/.

Table 3.   File summary in research database

Database File Summary		
Description	**File extension**	**Count**
Text documents	.txt, .doc, .docx, .pages	294
Web logs	.html	8
Calendar events	.ics	67
Images	.jpg, .png, .pxm	15
Documents	.pdf	183
Briefs	.ppt, .pptx, .key	106
Spreadsheets	.xls, .xlsx, .xlm	89
Emails	.eml, .pdf	12,264
Total		13,026

d.   Data Processing

To process the various records, I used many tools and adopted several techniques to extract key pieces of information from the large volume of data. To manipulate and clean the large volume of data, I imported files into DPO. After running data de-duplication, I binned the data into 15 equal time periods to create a consolidated timeline of events from the archival records (Appendix B). From these time periods, I extracted all text from the different document types and exported 15 text files that required further processing for the quantitative analysis.[10]

To clean the 15 text files (which each corresponded to a period), the files were individually imported into AutoMap—a text refinement and processing tool that enables the creation of semantic networks from plain text files developed by Kathleen Carley at Carnegie Mellon University.

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[10] While the entire data table was used for the case study and the development of the timeline and organizational participation charts, the significant volume of email unnecessarily added "noise' to the data used in the quantitative analysis. As such, the emails were removed from the 15 time periods referenced in the quantitative analysis chapter.

Once in AutoMap, the text files were processed to remove noise (e.g., prepositions, numbers, articles of speech),[11] map common words to core concepts (e.g., analyze, analysis, analyzed all map to the concept "analysis"), and ready the text to generate semantic networks. Once the processing and refinement were complete, AutoMap was used to generate the semantic networks that were then imported into the Organizational Risk Analyzer (ORA) for analysis.

For the topic modeling, the cleaned files were exported from AutoMap and imported into the Topic Modeling Tool (TMT). Once in the TMT, topics were generated and exported for further analysis.

For the lexical analysis, the cleaned files were exported from AutoMap and imported into Lexos. No additional data cleaning procedures were applied and the lexical analysis was conducted within the tool.

e.   *Development of a Consolidated Timeline of Events*

To ensure an accurate, longitudinal representation of the innovation process, key events were extracted from the archival records. Where meeting minutes were used, key participants, organizations, location, and discussions were captured and recorded for crosschecking during the development of the case study. In the case where meeting minutes were unavailable, the last modified dates for the archived document (typically PowerPoint briefings) were used to approximate the event date for a briefing, meeting, and information paper. Finally, events (meeting invites, discussions, informal coordination) and records pertaining to the briefings were extracted from email records, crosschecked, and incorporated into the data structuring process (see Table 4 for an example). A consolidated timeline is available in Appendix B.

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[11] As part of the cleaning process, an extensive delete list was generated. This list included not only the standard prepositions for removal, but also included additional words that would remove noise from the text documents. The result of using a delete list and a thesaurus ensured that the text files used to generate the semantic networks included the fewest number of errant words (i.e., noise) as possible.

Table 4. Excerpt of consolidated timeline

Date	Event	Type	Name	Topic
11/6/2009	FIST Test Concept for SE Asia	Proposal	FIST	Test concept for SE Asia; As part of the data collection and proof of concept phase for the FIST project, FIST has secured invitations to Cobra Gold 2010, Balikatan 2010, and is a coernestone project for the newly created NPS Pacific Research Alliance between NPS and Thailand.
11/18/2009	John F. Kennedy Special Warfare School	Presentation	FIST	Briefings to General Officers
11/9/2009	FIST vs Small Worlds vs TIGR Comparison	Technical	FIST	System comparison
11/30/2009	CG, US Army Special Forces Command	Presentation	FIST	Briefings to General Officers
12/9/2009	FIST CORE Proposal (Military Geography)	Proposal	FIST	Military Geography
1/20/2010	Geo-mapping conference with the 95th Civil Affairs Brigade	Conference	FIST	Attendance at CA conference
1/22/2010	CG, USASOC	Presentation	FIST	Briefings to General Officers
2/7/2010	FIST proposal to CNTPO	Presentation	FIST	Proposal
2/11/2010	Master Brief Template	Brief	FIST	Project document

f.   Identification of Key Organizations from Records

In addition to developing a consolidating timeline of key events, I identified the organizations involved in the innovation process. Because this study is focused on the innovation process within the DOD, it was important to identify the organizations involved with the project during the study period. I created an organizational table from the archived records and briefings to consolidate and group the list of organizations involved in the study (Table 5). Appendix C contains the master table of organizations involved in the innovation process. The organization list extracted from the archival records was used during the development of the case study.

Table 5.   Organizations included in the study

Special Operations Commands

	USSOCOM	USPACOM	SOCPAC	1st SF Group	JSOTF-P	MARSOC	USASOC
Organization	US Special Operations Command	US Pacific Command	US Special Operations Command - Pacific	1st Special Forces Group	Joint Special Operations Task Force - Philippinnes	US Marine Corps Forces Special Operations Command	US Army Special Operations Command
Description	Headquarters for US Special Operations headquartered in Tampa, Florida.	Geographic Combatant Command responsible for the Pacific AoR	Theater Special Operations Command for the Pacific AoR	One of several standing Special Forces Groups, Headquartered at Joint Base Lewis-McChord	Task Force established in the Phillippinnes to conduct counter-terrorism operations	Service Component for Marine Corps Special Operations	Service Component for Army Special Operations

Marine Corps Commands

	SYSCOM	MARFORPAC	MCCMOS	3rd CAG	MCIOC
Organization	Marine Corps Systems Command	Marine Corps Forces Pacific Command	Marine Corps Civil-Military Operations School	3rd Civil Affairs Group	Marine Corps Information Operations Center
Description	Acquistion and R&D lead for all USMC programs of record	Component Command for the Pacific AoR	Service-level school house for civili-military training	Pacific oriented civil affairs command based in Okinawa, Japan	Service-level organization for Information Operations for the Marine Corps

Science and Technology Organizations

	CNPTO	AGC	MEC	ONR	CORE	COAST
Organization	Counter Narcotics Technology Program Office	Army Geospatial Center	MARFORPAC Experimentation Center	Office of Naval Research	Common Operational Research Environment	Combined Operations, Science and Technology Field Research Program
Description	OSD level organization that funds and develops science and technology for counter-narcotics programs	Lead agency for Army Geospatial analysis and capability development	Lead science and technology agency for Marine Corps Forces Pacific	Lead science and technology agency for the Department of the Navy	Research laboratory in the Defense Analysis department at the Naval Postgraduate School	Field experiment program at the Naval Postgraduate School that focused on international field experimentation

g.   *Case Study Development*

During the collection and processing of the data, key events and concepts were extracted from the archival records using a coding and tagging scheme. By applying the constant comparative technique (Glaser & Strauss, 2009), I continually referenced new data with previously analyzed data to develop a conceptualization of the innovation process as it evolved in time. These observations were incorporated into the case study.

After describing the events in the case, I present the tables of the communication events to highlight the various ideas and narrative used to describe the new idea to different audiences. These tables and the case description are probed in greater depth in

the case analysis. Two insights about the management of ideas are presented after the case.

h.   *Quantitative Analysis*

The quantitative analysis conducted in this study uses three separate, but related text analytic procedures to empirical test the insights generated from the case study. These insights are tested concurrently and the integration of the three quantitative methods is discussed in detail in the subsequent chapter.

(1)   Semantic Network Analysis

After finishing the case study, I conducted a longitudinal semantic network analysis of the archival records to track the evolution of the innovative idea over time. For this research, I analyzed the semantic networks using social network analysis (SNA) to understand the evolution and changes to the idea. While it is assumed the reader has some familiarity with social network analysis, a brief introduction is provided in Appendix A for those desiring a deeper discussion than is provided in the quantitative analysis chapter.

Semantic network analysis extends the concept of relationships among people and treats concepts in a text document as nodes in a network and the proximity of those nodes to each other as relational ties. Proximity can be defined as words appearing in the same sentence, paragraph, page or chapter and is based on how the researcher defines this proximity (Carley, Columbus, & Landwehr, 2013). In this case, concepts were deemed to be proximate if they occurred in the same sentence and a relational tie was established between two concept nodes. I chose this approach (over the co-occurrence in a paragraph or page) as it was the smallest unit of measure that would encapsulate the typical response to the question, *"What is Lighthouse?"* A response would be given in a form such as *"Lighthouse is ..."* where the remainder of the sentence described the innovative idea.

To further define a semantic network, words that reference the same concept can be mapped to a single concept such that concepts like *analyze*, *analysis*, *analyst* all can reference the single concept of *analysis*.

Once a semantic network has been defined and generated, traditional social network analysis metrics can be applied to garner insights into the semantic networks. This analysis can reveal commonality of terms and important concepts based on centrality ranking, and can highlight the shift in use of words over time if the network is coded longitudinally.

Beyond the common social network analysis measures that can be applied to a semantic network, this study has adopted a typology of semantic categorization from Carley and Kaufer (1993) that averages consensus[12] (weighted degree or number of graphs of the number of reports the tie is present), conductivity (betweenness centrality), and density (degree centrality) to create a composite score, which is then tied to the typology: ordinary words, allusions, placeholders, buzzwords, factoids, emblems, stereotypes, and symbols (see Figure 6).
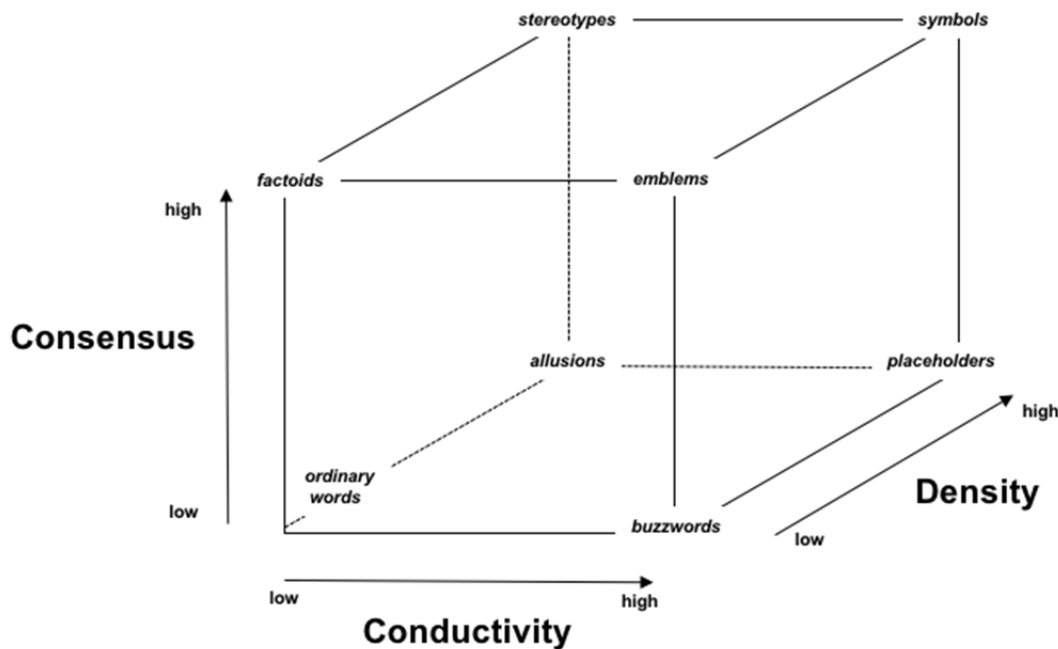
Figure 6.   Semantic Typology. Source: Carley and Kaufer (1993)

(2)   Topic Modeling

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[12] Consensus is defined as "the number of direct links that meet or exceed some threshold" (Carley & Kaufer, 1993). It is best understood as a word that appears across several semantic text networks.

Having processed the text files earlier using AutoMap, the 15 text files were imported into the TMT for analysis. The corpus of text was selected as the input source for the TMT, and 10 topics were generated. The outputs of the TMT provided both Comma Separated Value (CSV) and Hypertext Markup Language (HTML) files that were used in the development of the 15 charts provided in Chapter V.

(3)   Lexical Analysis

In a similar fashion as the topic modeling, the cleaned text files were imported into Lexos for analysis. Once queued in Lexos, the dendrograms, Voronoi diagrams, document similarity comparisons, and clustering diagrams were generated from the cleaned text files and are further described in Chapter V.

4.   Discussion and Conclusion

Upon completing the case study, the semantic network analysis, topic modeling, and lexical analysis, the insights gained from these distinct approaches provided a comprehensive, holistic, and longitudinal view of both the development and refinement of a new idea over time and the entrepreneurial activities required to manage an idea as it moved from concept to acceptance. With this view, I transition and present the major findings of the study before concluding the discussion. The quantitative analysis can be found in Chapter V while the discussion and conclusion are found in Chapter VI.

D.   QUALITY AND TRUSTWORTHINESS OF STUDY

The following section is a brief discussion on the ethical considerations of this study, its potential research bias and limitations. In this study, I am both a participant and an observer. While this dual role is discussed as a unique variable of the study, the potential for bias is a concern and has the potential to skew results. To minimize bias, external participants from the Common Operational Research Environment (CORE) Lab have fact-checked and verified the events as described. Additionally, the incorporation of the archival data increases the reliability of the information contained in the case and the subsequent analysis (triangulation).

The main ethical consideration in case study research is the protection of the confidentiality and anonymity of the participants involved (Stake, 2013). To maintain such confidentiality and anonymity, the case study uses pseudonyms for the participants where appropriate. The organizations involved are a matter of public record and have not had their names altered in any way. Because the archival data includes names of individuals who were involved with the new idea, the data set has been completely anonymized and stripped of any personally identifying information.

While this work aims to generate theory related to the management of new ideas and their meanings during the innovation process, it is not without limitations. First, it uses a single case rather than multiple cases to advance theory. While case studies enable a topic of interest to be explored "in the wild" without experimental control or manipulation, this study is limited in the sense that it is a singular observation of entrepreneurial and innovative activity within a context. Although the results observed have the potential to be representative of the management of ideas in the innovation process external to the DOD, additional research is required to determine if the propositions generated from this research hold true in other contexts.

Secondly, the semantic network, topic modeling, and lexical analysis that augments the case study is based on an incomplete data set. Because of the nature of collection (only documents in which the researcher was involved or aware of are incorporated), important aspects of the communication of the innovation and management of the idea are likely missing. The archival data are incomplete and do not contain every document or email that occurred during the studied period. Data corruption, email loss or deletion, and misplaced files are factors that undoubtedly have affected the completeness of the data set. However, these losses have been minimized by crosschecking events with other sources (calendars, meeting notes, travel documents) from my holdings and from others within the CORE Lab.

While many measures for network analysis assume that a complete network is represented, the reality is that researchers conduct analysis on imperfect and incomplete networks. Although the missing network information has the potential to skew the results, the blending of the semantic network analysis with topic modeling, lexical analysis, and

the case study aims to minimize the impact of missing data. This technique has been applied in other studies (such as the studies on the Enron collapse) that blend publically available information with a network analysis of email networks to better understand the inner workings of phenomena of interest (Diesner & Carley, 2005; Murshed, Davis, & Hossain, 2007).

This chapter has provided an overview of the study's research design and its methods. I also detailed the reasoning behind blending a case study with a quantitative analysis to develop a more nuanced understanding of the innovation and entrepreneurship processes.[13] In addition, this chapter has identified and acknowledged the limitations of this design, and wherever possible, has attempted to minimize their impact. The following chapter presents the case study of the new idea and the entrepreneurial activities that facilitated its emergence as an innovation.

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[13] Additional details about the data collection, management, and analytic processes can be found in Chapter V.

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IV. CASE STUDY AND ANALYSIS

A. INTRODUCTION

This chapter presents a chronology of events surrounding the development of a new idea within the DOD. The historical overview begins in early 2008 and continues through early 2016. This case study is a description of two processes: the evolution of the new idea over time and the entrepreneurial activity required to manage and move idea through the innovation process. The names of the participants have been anonymized using pseudonyms except for Dr. Nancy Roberts, who gave her permission to be named in this study.

To anchor the organization of this chapter for the reader, Figure 7 highlights where the following inquiry is nested within the overarching research strategy. The case study was developed from three major components. The first component is comprised of the entrepreneur's experiences, lived reality, and the initial idea. The second component of the case study is comprised of the archival records described in the previous chapter. The third component of the case study is comprised of the case development and evolution of the idea. These components are presented through the lens of three conditions: the case study is nested in a public-sector organization (first condition), the DOD (second condition) and focuses on the actions and activities of an entrepreneur and his team from a bottom-up perspective (third condition).

The case study begins in 2009 with the initiation of the new idea and the motivations that created the original problem that was to be solved. The case flows through the innovation process steps observed in the case (initiation, design, and implementation) before transitioning to an analysis. Within the case analysis, I identify two insights regarding the management of ideas that are generated from the interpretations found in this analysis which will be explored in greater depth in the subsequent quantitative analysis chapter.

Research Strategy

1. How do ideas develop and evolve over time as they move through the innovation process?

2. How do entrepreneurs manage the meaning of an idea as it evolves over time?
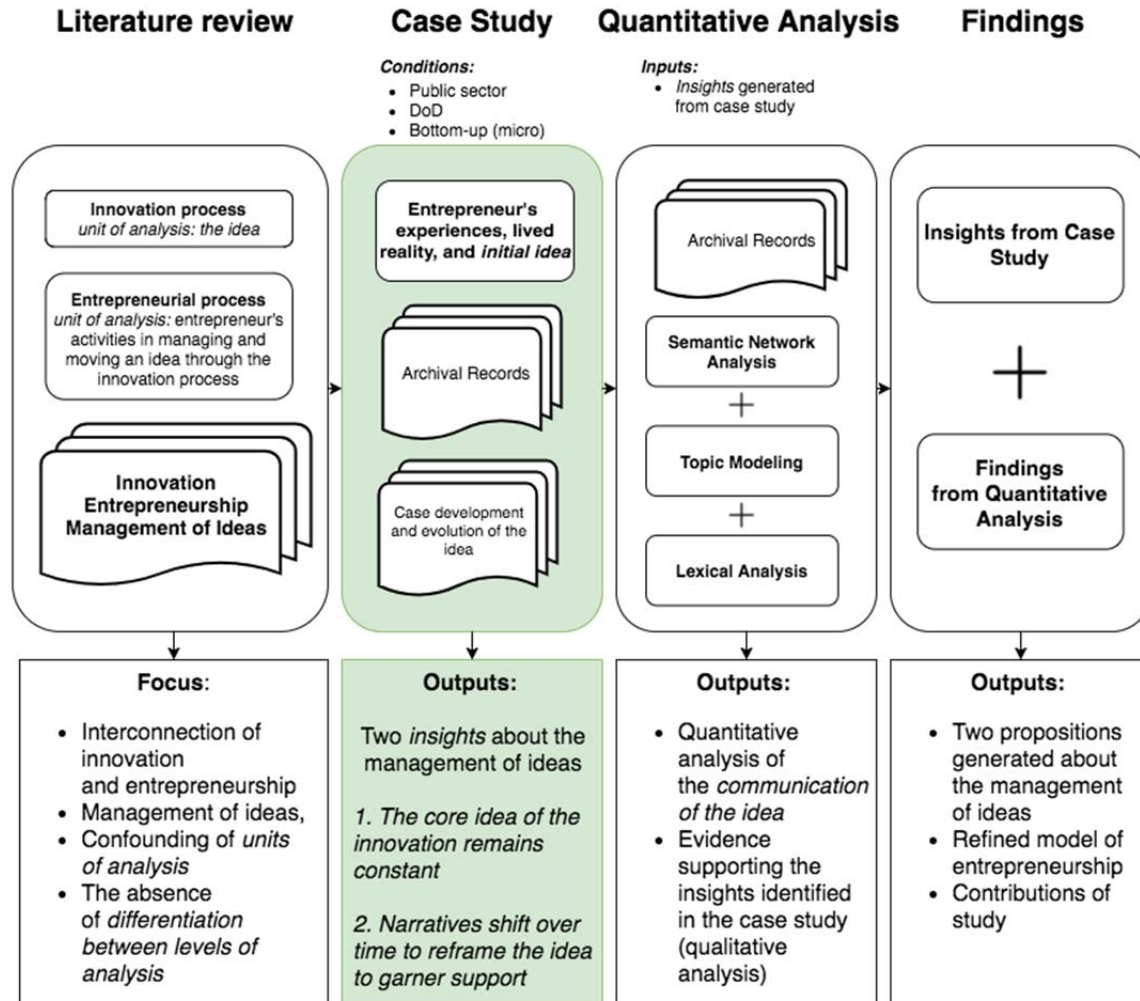
Figure 7.   Research Strategy Map–Case Study Conditions, Inputs, and Outputs

B.   CASE DESCRIPTION

In 2009, I set out to produce a thesis that was meaningful, relevant, and useful as a means of "giving back" to the organization that afforded me the opportunity to advance my education. I had just returned from a combat deployment to Ramadi, Iraq, and had witnessed several organizational, informational, and system challenges that affected the performance of our jobs. I wanted to address what appeared to me as "fixable" problems.

At the time, the Marine Corps had been employed operationally in two theaters of war, Operation Enduring Freedom (OEF) in Afghanistan and Operation Iraqi Freedom (OIF) in Iraq. The Corps was facing considerable challenges on both fronts as it adapted to a new form of warfare, Counter-Insurgency Operations (COIN), and adopted new technologies to deal with the volumes of data and information required to fight these wars. While many will argue that COIN was in fact not new, what was different was the volume and fidelity of information that was collected and made available to the soldiers, sailors, airmen, and Marines on the battlefield.

Over the next several years, I embarked on a journey that would take me across most of Asia and the United States and employ tools used during deployments in support of operations ranging from humanitarian assistance missions in Southeast Asia, Village Stability Operations (VSO) in Afghanistan, and counter-gang operations in the streets of California. I would brief countless Admirals and General officers in the DOD and have meaningful conversations about tackling some of the most significant data and information challenges the DOD faced. Unknowingly, at least initially, I would participate in and observe innovation inside the DOD from a unique perspective—as both the lead entrepreneur and researcher—and would watch as interest, support, and use ebbed and flowed across organizations, and services.

After finally turning over the reins on my project and transferring from NPS in mid-2012, I realized that I had in my possession a unique story and a comprehensive data set that would allow me to analyze and synthesize over 7 years' worth of data. These data cut across geospatial, temporal, and relational boundaries that would, for the first time, provide a unique look at the innovation and idea generation process inside of the DOD. Additionally, my education and experiences had opened my mind to a completely different viewpoint on life, one based not on objects and artifacts, but on the relationship of those artifacts and objects to others. This unique perspective as entrepreneur, participant, and observer can enable a deeper investigation into the innovation and entrepreneurial processes and allow us to visualize the complex path an idea takes as it is moved through time.

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1.   Initiation of the New Idea

Upon arriving at NPS in April 2008, the first three quarters of my time at NPS were spent learning calculus, physics, and computer science for the prerequisites in the Information Warfare Systems Engineering (IWSE) curriculum. Having spent my undergraduate time as a Spanish major, my first year at the NPS was spent buried in books trying to make sense of the formulas and applications necessary to begin the "real" graduate work. After having spent a considerable amount of time in the classroom, I became immediately interested in conducting field research and getting my "hands dirty" with experimentation. I had heard about a program called COASTS run by an Information Sciences Research Associate, Alan Yann, which conducted half of the field experiments in California and the other half in Thailand. The COASTS program piqued my interest, and I contacted Mr. Yann about joining the team.

I was invited out to the second field experiment (FEX) held by COASTS at Camp Roberts, just outside of Paso Robles, California, where I was introduced to several individuals who worked with the COASTS program. As my interests were in communications, I was immediately drawn to the network engineers with whom I spent the next several days collaborating about my future thesis topic. At the end of the FEX, I decided I wanted to integrate small-level tactical radios with commercial off-the-shelf cellular phones to create a "hybrid" communications network. This concept was founded in my frustrations in Iraq in 2007, where we had difficulty sending very short situation reports from positions only a few kilometers from the command and control center aboard Camp Ramadi. This lack of connection drove me to consider how we could use advanced technology to solve our problems.

After leaving FEX II, I immediately began to shop this idea around the department to gauge interest in the project and to find potential funding sources to purchase the necessary equipment, acquire a travel budget, and find a sponsor who found the work relevant and useful. After a month or so of this effort, it became apparent to me that while the research was interesting, it was not the impactful research I was looking for as it lacked substance and context. With that in mind, I turned to the senior Information Warfare students to try to get a rudder check on which direction to take. Two Marine

Majors who were in the senior Information Warfare (IW) curriculum, suggested I look at the work the CORE Lab on campus as it seemed to have similar interests to mine.

With that in mind, I emailed Dr. Nancy Roberts in the spring of 2009 and arranged a meeting with her a few days later. I walked into Dr. Roberts's office one morning after finding her name on the lab's website and plainly spoke of an idea I had for collecting and transmitting information in the field using smartphones (the concept had evolved slightly since I left FEX II). She seemed enthusiastic about the idea (the first professor on campus to express such interest) and suggested I meet with and discuss the idea further with Chief Warrant Officer 3 Darrell Frank, a student in the Defense Analysis (DA) Special Operations Low Intensity Conflict (SOLIC) curriculum. Chief Frank is an Army Special Forces (SF) student with a considerable amount of time spent deployed and in the field operating at the small-unit level. He and I immediately connected and cooperatively began to shape the concept.

a. The Human Terrain Analysis and Collection System

This project also drew on a frustration I experienced in Iraq, where I witnessed several smart Marines spend an inordinate amount of time attempting to clean and process data to get it into the appropriate format for analysis. I often observed analysts spending nearly 80% of their time (or more) manipulating data to get it into the right format and approximately 20% of their time doing actual analysis. This, I thought, was a huge waste of their time and severely limited the efficiency of our analytical cell. I suggested to Chief Frank that perhaps the design of a system to collect, process, and structure data on the sociocultural landscape was the best application of this concept, and I named this idea the Human Terrain Analysis and Collection System (HTACS). While I had the technical wherewithal to integrate a system, I was not a software engineer so I reached out to another Information Warfare (IW) student with a programming background to combine our interests and capabilities.

Taking a framework that Chief Frank developed based on a class he took at NPS, I set out to see what I could do to operationalize this framework (what we would later call the Military Geography). Using some initial funding from the information warfare

curriculum, we bought several iPod touches (as the cell phones were too expensive) and worked on a mockup application to demonstrate during an upcoming field experiment in Thailand.

Later that spring, COASTS transitioned into a Marine Forces Pacific Command (MARFORPAC) Experimentation Center (MEC) exercise called CRIMSON VIPER (CV). This exercise served as the technology precursor to COBRA GOLD, an annual bilateral military exercise between the Royal Thai Armed Forces (RTArF) and the U.S. military. During CV 2009, I set up a booth to discuss this technology mockup to garner more interest in our work and find an appropriate demonstration and testing ground for work now being done in partnership with the CORE Lab. While the application was only a mockup, HTACS began to get interest from several organizations attending the technology day. The MARFORPAC G-3 (Operations Officer), expressed interest in the work we were doing, but suggested that the name needed a change to something more "vanilla." The notion of collecting data on humans would not sit well with many people and the name would be associated with the troubled Human Terrain System program out of the Defense Intelligence Agency (DIA). Following the exercise, HTACS was officially renamed the Multi-modal Information Support Tool (MIST).

b.   *Multi-modal Information Support Tool*

I continued to brief the MIST concept to procure an appropriate sponsor, and to that end I traveled to the Office of Naval Research Global (ONR-G) in Tokyo and the Office of Defense Cooperation (ODC) in Cambodia, and met with and briefed several U.S. and Thai agencies in Thailand on MIST. We continued to create and refine briefs and product mockups, but had not developed a functioning prototype. We continued to garner strong demand signals everywhere we briefed the concept, but had not yet found a sponsor that would enable a transition from a concept on paper to a functioning prototype.

In Monterey, I took two of the CORE Lab courses, Geospatial and Temporal Dimensions of Dark Networks (DA3600) and Dark Networks (DA4600), during which time my ideas became even more defined. Both CORE Lab courses were structured

around using advanced analytic techniques to explore, visualize, and analyze networks of illicit, terror, and criminal organizations to gain meaningful insights into their structure and operations. These insights could be used to craft intervention strategies to counter these organizations. To gain these insights, however, the analytic techniques were predicated on obtaining structured, geospatial and sociocultural data—something not easily obtained at the time. The challenge of data acquisition and data structuring became one of the key components of the idea moving forward.

2.   Transition to Design

After solidifying the concept for the idea—a mobile data collection system to enable sociocultural and ethnographic intelligence—it was time to move from ideas on paper to a functioning prototype that could be demonstrated and tested under field conditions.

a.   *Gaining Acceptance of the New Idea's Design*

Once the mobile data collection system concept was fleshed out, I needed to gain acceptance from senior leaders to obtain sponsorship—either in terms of operational support or in terms of resourcing to develop a prototype of the system. Darrell and I continued briefings on campus and abroad and I finally could brief the Commander of U.S. Special Operations Command (SOCOM) and several other senior executives. Because of Alan Yann's new position out at U.S. Pacific Command (PACOM) as a NPS liaison, the MIST concept had been introduced to Special Operations Pacific (SOCPAC), which worked diligently to see how we could introduce it into their AOR. SOCPAC tried to find the appropriate funding within the Department of Defense, first with the Navy IW group at OSD and finally to the Counter Narcotics Technology Program Office (CNTPO) in Dahlgren, Virginia. As with many government projects, obtaining funding for a new program and navigating through the contracting process would take a considerable amount of time. It took more than six months from the time of the initial discussions with SOCPAC until the final contract award to Kestrel from the CNTPO.

In late 2009, the strategic initiatives group lead for the U.S. Army Special Operations Command (USASOC) liked our concept enough to have Chief Frank and me

fly out to Fort Bragg, North Carolina, in February 2010 to present our idea to the Commanding General (CG) of USASOC. The CG loved the idea of ethnographic intelligence and directed his staff to start working to integrate ethnographic intelligence into the SF training pipeline. Additionally, he was interested in exploring how a prototype of MIST could be used as a technology insertion during ROBIN SAGE, the last exercise in the SF training course. Chief Frank and I returned to Monterey and continued working on our design to determine how to implement it with USASOC. We now had two main initiatives, one with SOCPAC and the other with USASOC, which had not only potential funding but also the operational applicability we were needed.

In early spring 2010, I came across the Open Data Kit (ODK) project, an open-source data collection and repository system developed out of the University of Washington, that I thought might be a way to operationalize the MIST concept. I quickly read up on everything I could on the ODK suite, and designed an initial prototype of MIST in late spring. I prepared the prototype for an upcoming exercise in Thailand called Combined Operations Afloat and Readiness Training (CARAT) where I would demonstrate our first prototype of MIST. To avoid confusion between our tool and the Military Information Support Teams (MIST) embedded in many embassies, and on the advice of Alan Yann, we changed the project name again to the Field Information Support Tool (FIST).

During CARAT Thailand 2010, I went to the Sattahip Naval Base in Thailand, where I collected data for a notional humanitarian disaster and mapped several hospitals, pharmacies, and medical clinics that could be used if another disaster occurred in Thailand like the tsunami that had killed several hundred thousand people in Southeast Asia in 2004. Using what we called FIST-Light, I demonstrated the ODK prototype with our collection forms for the first time in a field environment.

On the heels of CARAT Thailand, a FIST write-up was featured in the NPS newsletter and a DOD-wide monthly situation report (SITREP) about FIST was widely circulated through email. From these email communications, I began receiving daily emails about FIST and its application across a wide range of operations, from humanitarian assistance to combat operations in Iraq and Afghanistan.

The entrepreneurial team—the lead entrepreneur (me), members of the CORE Lab (primarily Dr. Nancy Roberts and Chief Frank), and Kestrel—continued to refine the system. Although we still lacked external funding to develop the major components of FIST, the project team received Asia Pacific Regional Initiative (APRI) funds from PACOM and approval to participate in PACIFIC ENDEAVOR (PE) 2010.

Both CARAT 2010 and PE 2010 provided opportunities to test and demonstrate the idea in a variety of environments. During these events, I received feedback and employment considerations for FIST-Light that would be incorporated into future designs of the prototype.

b. Gaining Organizational Support

Shortly after CARAT, I briefed the Marine Corps Director of Intelligence and the CG of Marine Training and Education Command (TECOM) in the CORE Lab at NPS. Following this meeting, I was instructed to submit an extension package to remain aboard NPS for an additional two years to see the project through to its fruition. Before leaving for Singapore, I received my extension (an unheard-of two-year extension with an option for enrolling in the Information Sciences Doctoral program) and diligently worked to get our system ready for PE 2010.

During PE 2010, another Marine student and I travelled to Manila, where we collected notional disaster data in Manila and sent these reports, through cellular networks, to the Changi Command and Control Center in Singapore. Again, we demonstrated the utility of this system prototype and the write-up of the event was circulated throughout the DOD.

c. Prototype Testing in Afghanistan

Shortly after PE10, USASOC sponsored the FIST prototype to be tested in Afghanistan with Chief Warrant Officer Frank leading the effort on the ground. The aim of this test was to demonstrate the viability and utility of the prototype in support of the VSO platform in and around Kandahar.

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For three months, Chief Frank took a handful of phones to Afghanistan to demonstrate the collection capability of FIST and the CORE Lab's advanced analytic methodology and how it could be applied to COIN operations on the ground. This three-month effort led to the exposure and validation of FIST and the analysis techniques at the tactical level and requests for support began flowing almost immediately into the CORE Lab following this pilot (Figure 8).

Afghanistan pilot results

"One of the main things I like about the capability is that the material presented exactly coincides with the understanding that I gained from my experience in this region, here in Afghanistan for three years, and 36 years of USDA experience in the field working with tribes and clans in the U.S."
        --Jim Green, SOTF-S USDA Agricultural Advisor

"I have worked in this district for almost a year, and the products depicted using FIST directly coincide with my own conceptual understanding of the communities in this district—products which were developed in only two weeks time by an operator new to the area."
        --George Hale, SOT-S USAID Developmental Advisor

Figure 8.   Afghanistan Pilot Prototype Test and Feedback

After Chief Frank returned from Afghanistan, the CNTPO contract was finally awarded for the development of FIST for SOCPAC (November 2010) with commercial development of FIST to begin immediately. Unfortunately, the collaboration between Kestrel and CORE divided over a disagreement with the way forward. On one hand, Kestrel Technology Group finally received funding to take the FIST-Light prototype and develop a product for use by SOCPAC. On the other hand, the commercial development of FIST meant the government (i.e., the entrepreneur and CORE Lab) would no longer play an active role in the design and development of the FIST source code. As there was a desire to continue exploring and refining the data collection concept for sociocultural and ethnographic intelligence, the decision was made by the entrepreneur and the lab to split efforts from the commercial work of Kestrel. In late December, the collaboration team officially split into two groups. Kestrel worked to develop and transition FIST into a

commercial product and the lab promoted an open-source alternative known as OpenFIST.

d. *Divergent Paths: Open Field Information Support Tool*

OpenFIST became the fourth name given to the idea and the project team refocused their efforts towards designing low-cost, open-source and government owned solutions for SOCOM and the Marine Corps.

The split between Kestrel and the CORE Lab caused considerable consternation within the community at first, but the desires to further the research into mobile data collection for the DOD was, in my opinion, the best path forward for the idea. OpenFIST became one of the focal points for the lab with initiatives planned or underway in Afghanistan, counter-gang operations in Monterey County, and other locations and missions throughout the world.

In early 2011, the entrepreneurial team[14] continued to test and evaluate various commercial and open source software platforms to improve the data collection and processing capabilities of the tool. This iterative testing included moving from the Android platform back to the iOS platform and integrated newer technology that was more secure, flexible, and dynamic than the previous systems. To differentiate between the commercial and government efforts, and to minimize friction between the CORE Lab and the now commercially developed FIST, the name was again changed to Lighthouse.

e. *Lighthouse*

The renaming of OpenFIST to Lighthouse was an effort to separate the CORE Lab prototype from the Kestrel prototype. By eliminating the use of "FIST" in the Lighthouse name, the prototype could be more clearly differentiated by external

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[14] In early 2011, the entrepreneurial team consisted of me (as the lead entrepreneur), Chief Frank, Dr. Nancy Roberts, and a few members of the CORE Lab. The entrepreneurial team changed over time due to individuals joining NPS or leaving NPS for one reason or another. While team membership changed over time, I differentiate between my role as the lead entrepreneur, the entrepreneurial team which includes the aforementioned individuals, and the extended entrepreneurial network which included a variety of individuals and organizations that facilitated or enabled the communication of the idea throughout the DOD.

audiences. By using the symbol of a lighthouse, we attempted to convey the image of shining light into darkness to guide navigators safely into harbor. Additionally, we used the tagline "Illuminating social networks to navigate the human terrain" to reinforce the ethnographic intelligence emphasis.

By early 2011, Lighthouse had several prototypes and field tests underway. These tests included operationally testing Lighthouse in support of the Special Operations Task Force West (SOTF-W) in Afghanistan, an emerging prototype test with the Gang Task Force (GTF) in Monterey County, California, and collaboration with the Massachusetts State Police (MSP) Special Projects Team (SPT). Additionally, the Lighthouse team began collaborating with the Marine Corp Information Operations Center (MCIOC) on the development of an Information Operations (IO) reach-back support tool using the military geography framework we developed as part of the FIST effort.

In addition to the collaborations, the entrepreneurial team worked to develop additional proposals for prototype development, analytic training, system fielding, and analytic support for Special Operations Command Central Command (SOCCENT) requirements in Yemen and support to Colombian Special Operations Forces in Bogota, Colombia. With these efforts, our focus remained on fielding a sociocultural data collection prototype and espousing the development of our methodology for integrated network analysis (referred to as the CORE Lab methods).

f.   Support to Special Operations

In March of 2011, the project returned to Afghanistan in a limited test capacity to support data collection and analysis for SOTF-W in Herat, Afghanistan. The results of the SOTF-West Lighthouse implementation included positive feedback from Special Operations Task Force–Southeast (SOTF-SE) and Combined Joint Special Operations Task Force–Afghanistan (CJSOTF-A). Additionally, the Civil Military Operations Center (CMOC) was keenly interested in adopting Lighthouse to replace the currently deployed civil information management system as the current system in use was antiquated and frustrating to use. While we were enthusiastic about the positive feedback, Lighthouse continued to face resourcing and policy hurdles that prevented a transition from prototype

to implementation. Nevertheless, with a positive formal evaluation from SOTF-SE, SOTF-W, and CJSOTF-A, we incorporated the vignettes for many of our briefing slides to garner further support for our project.

Building on these vignettes, I submitted an essay to the Joint Special Operations University (JSOU) entitled *Redefining Intelligence Support*, which won the first prize (Longley, 2011). This paper outlined the collaborative effort between SOTF-W analysts and CORE Lab researchers to collect and analyze sociocultural data to enable shared understanding of the environment. The focus of this paper was to highlight the numerous iterations of the prototype and the field testing of ethnographic intelligence in support of Special Operations Forces (SOF). Following the publication, word continued to spread on the CORE methodology and Lighthouse.

g.   *Support to Homeland Security*

In the beginning of 2011, the Department of Homeland Security funded the Lighthouse project via the California Homeland Security Consortium (CHSC).[15] This effort was a collaboration with local law enforcement to enable system integration and modernization of the field interview (FI) process used by police. These records were manually collected while on patrol (if at all), and the input of the FI cards into a database to enable analysis was a laborious process. After demonstrating value in using social network analysis for counter-insurgency purposes (borrowed from the Afghanistan experiences), we worked to develop and improve the sociocultural data collection prototype for the task force. By March 2011, Lighthouse was being tested in Springfield, Massachusetts with the Massachusetts State Police (MSP) Special Projects Team (SPT), and the Monterey GTF integration efforts began shortly thereafter.

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[15] While the Department of Homeland Security falls outside of the DOD, the funding decisions for the project were made by the California Homeland Security Consortium (CHSC)—a group of individuals and organizations that included members of the DOD. The CHSC was funded by the Department of State and in turn selected projects for funding at the Naval Postgraduate School. Thus, the specific example given here is best understood as a collaboration with the DOD and DHS, rather than being firmly nested in DOD alone.

3. From Design to Implementation

In June 2011, the entrepreneurial team began a collaboration with the MEC that would finally mark the transition of the idea from the design stage to the implementation stage of the innovation process. This collaboration would enable a student project to be transitioned from a functioning prototype to forming a part of a fielded, program of record (POR) within the Marine Corps.

I had worked with the MEC on a few occasions with our field experiments with FIST (CRIMSON VIPER being the first formal occasion) throughout 2009 and 2010 during various field experiments in PACOM. In addition to organizational familiarity, I had previously communicated with and briefed a few of the individuals with both the MEC and the Office of Naval Research (ONR) on our field data collection concept.

As it would turn out, the MEC was looking for a viable replacement for their mobile data collection tool called MIKA, a commercial tool, and they were interested in exploring whether Lighthouse could serve as that replacement. In October, the MEC and the CORE Lab held an official kick-off meeting for the development of the Marine Civil Information Management System (MARCIMS) effort and data collection began shortly thereafter in several countries: data were collected by the 11th Marines in Guatemala and Ecuador, medical planners collected data in the Philippines, and Lighthouse was used in Quantico, Virginia to train students in the civil affairs school. In November, I flew out to Okinawa, Japan with a few individuals from the Army Geospatial Center (AGC) and the MEC to conduct training for the III MEF Civil Affairs (CA) Marines (Figure 9) on field data collection.

Figure 9.   Instructing CA Marines in Okinawa, Japan

Because of our collaboration and field testing, Lighthouse was formally chosen as a subsystem component for the MEC's civil information management and mapping system project. This integrated platform was to be used for data collection for the III Marine Expeditionary Force (MEF) in support of upcoming Theater Security Cooperation (TSC) events. MARCIMS was fully exercised during COBRA GOLD 12 and BALIKATAN 12 by the CA Marines. These collection efforts demonstrated the value of the MARCIMS platform under operational conditions and Lighthouse was formally funded as a subsystem component for the initial MARCIMS capability, and would be incorporated fully into the finalized PoR.

With the help from the AGC and the MEC, the field evaluation reinforced the Initial Capability Document (ICD) produced by the Marine Corp Combat Development Command (MCCDC) and the functioning prototype of the mobile data collection system was incorporated into the MARCIMS concept and became a part of the well-defined project plan. In Figure 10, I have included the plan of action and milestones for the MARCIMS project. This figure includes the principal events and activities from transitioning the prototype MARCIMS concept into a formal program of record (PoR) within the Marine Corps. The prototype mobile field collection software from Lighthouse provided the initial functioning tool used for the Cobra Gold Field Test (listed as "Limited CG11 Field Test"), the prototype build, the Security Cooperation Education Training Center (SCETC Field Exercise), Marine Corps Civil Military Operations School (MCMOSS) Training, and the COBRA GOLD 2012 Exercise.

Principal Events & Activities	FY 2010	FY 2011	FY 2012	FY 2013
	J A S	O N D J F M A M J J A S	O N D J F M A M J J A S	O N D J F M A M J J A S
Market Analysis/Phase 0 Prototype				
Limited CG11 Field Test				
Phase I Prototype Build				
SCETC (MCMOSS) Field Exercise				
MCMOSS Training				
CG12 Exercise/ Formal Evaluation				
MCCDC/SYSCOM IPR				
Balikatan 12 Exercise				
Transition Workshop				
Phase 2 Prototype Build				
Joint Experiment				
MCCDC/SYSCOM IPR				
Initial Operational Capability				

Figure 10.   Plan of Action and Milestones (POA&M) for MARCIMS

The activities described in Figure 10 moved the ideas from Lighthouse into the MARCIMS PoR where the management and oversight of the program was assumed by the Marine Corps Systems Command (MARCORSYSCOM) in late 2012.

a.   Project Spin-Offs

During 2011 and into 2012, two other student projects were created that were derived conceptually from the mobile data collection idea. The first of these spin-offs, called the Improvised Explosive Device Network Analysis (IED^{NA}), was built by two Naval officers for their master's theses. IED^{NA} used the same collection software used by Lighthouse to collect and structure data in the field for later analysis. What differentiated IED^{NA} from Lighthouse, however, was the purpose and type of data. IED^{NA} collected component information of unexploded ordinance and improvised explosive devices. Structured data was visualized and analyzed using the same techniques used by Lighthouse.

The second spin-off was the Lighthouse Sensitive Site Exploitation (SSE) project. Lighthouse SSE took the concept of field data collection and focused on enabling rapid site exploitation and site triage using mobile devices. This project acquired a separate line of funding for development and transition.

b.   *Project Conclusion*

In the spring of 2016, the Lighthouse project officially concluded. The CORE Lab decided not to pursue additional resourcing for the project as student interest in continuing the research project dwindled. While the student project has ended, the ideas, prototypes, and implementation from this effort can be found in a few products to this day. These include:

- FIST, the commercially developed platform by Kestrel Technology Group, is still available on the market today.

- MARCIMS, the official civil information management systems for Marine Corps Civil Affairs, continues as a program of record for the Marine Corps.

- Lighthouse SSE was further developed and incorporated into a suite of tools currently in use by U.S. SOF in Fort Bragg, North Carolina.

- The CORE Lab methodology and interest in social network analysis and data collection remains to this day in many organizations, partly attributed to the efforts of the Lighthouse project.

4.   Communication Events

Having now completed the description of the high-level events in the case, I wish to provide a greater level of detail to the communication of the ideas within the context of those events. Using the master event table (see Appendix B), I extracted all events that related to the communication of the idea. From this extracted table, I referenced the source documents for each event and developed a high-level description of the "narrative emphasis" for each item. The intent with this process was to display a short summary of the narrative for each of the major communication events of the idea as it moved through the innovation process. This process was intended to develop a concept map rather than a rigorous lexical analysis (this will be conducted in the subsequent quantitative analysis chapter). Tables 6–9 highlight the key communication events from February 2009 until April 2012.

Table 6.   Communication Events–Feb 2009–Feb 2010

Date	Event	Type	Narrative emphasis
2/1/09	Initial concept for field communication platform	Concept	Mobile data collection; ease of use; rapid reporting
4/1/09	HTACS FEX III test plan	White paper	Mobile data collection; ease of use; rapid reporting
6/15/09	HTACS briefing	Brief	Data collection system for human terrain mapping and military geography
6/15/09	SPAWAR Fellowship Proposal	Proposal	Sociocultural data collection system; emphasis on technical components and system development
8/1/09	SPAWAR Fellowship Submission	Proposal	Sociocultural data collection system; emphasis on technical components and system development
8/1/09	MIST brief	Brief	Mobile data collection system for multiple uses--HA/DR, Civil Reconaissance, field reporting
9/1/09	MIST brief for Thai MRDC	Presentation	Mobile data collection system for HA/DR and Civil Reconaissance
9/10/09	Update brief to ODC Cambodia	Brief	Open-source technology that can be used for collaboration between US and Cambodian units
9/11/09	Research Alliance Out brief	Presentation	Open-source technology for collaboration
10/4/09	Thesis modification	White paper	Data collection system for various use cases
10/5/09	iRAPIDS briefing to CAW	Brief	Sensor system with field data collection capabilities
10/16/09	Meeting with ONR	Brief	Research project focused that could support data requirements for various sociocultural projects
11/16/09	FIST Test Concept for SE Asia	Proposal	Field data collection system for human terrain mapping and support for sociocultural dynamics collection
12/9/09	FIST CORE Proposal (Military Geography)	Proposal	Field data collection system for human terrain mapping and military geography
1/20/10	Geo-mapping Conference with 95th CA BDE (1/20-1/21)	Presentation	Field data collection system for civil reconaissance that enables civil military operations
2/7/10	FIST proposal to CNTPO	Proposal	Field data collection system to support counternarcotics efforts and social network mapping
2/11/10	Master brief template	Brief	Field data collection system for multiple uses
2/22/10	Briefing to USARPAC, USPACOM J-9	Presentation	Field data collection system to support civil military operations
2/24/10	Briefing to MEC	Presentation	Field data collection system to support civil military operations
2/24/10	Briefing to PACOM J5	Presentation	Field data collection system to support exercises and humanitarian assistance / disaster relief
2/24/10	Briefing to PACOM J4	Presentation	Field data collection system to support exercises and humanitarian assistance / disaster relief
2/24/10	Briefing to PACOM J51	Presentation	Field data collection system to support exercises and humanitarian assistance / disaster relief
2/25/10	Briefing to Hawaii Center of Excellence	Presentation	Field data collection system to support exercises and humanitarian assistance / disaster relief
2/25/10	Briefing to Chaminade University	Presentation	Research project representative that could support data collection for various analytic processes and systems

Table 7.   Communication Events–Feb 2010–Aug 2010

Date	Event	Type	Narrative emphasis
2/25/10	Briefing to Pacific Disaster Center	Presentation	Field data collection system to support exercises and humanitarian assistance / disaster relief
2/28/10	Briefing to ONR SCCM Conference	Presentation	Field data collection system for sociocultural dynamics, social network analysis, and military geography
3/2/10	FIST brief built for USAID	Brief	Field data collection system for humanitarian assistance and disaster relief
3/3/10	FIST brief built for SCCM	Brief	Field data collection system for sociocultural dynamics, social network analysis, and military geography
3/3/10	SCCM Conference in Phuket, Thailand	Presentation	Field data collection system for sociocultural dynamics, social network analysis, and military geography
3/8/10	FIST brief for CMO	Brief	Field data collection system for civil reconaissance that enables civil military operations
3/20/10	FIST brief built for University of Central Florida	Brief	Field data collection system for human terrain mapping
3/25/10	FIST brief built for US Pacific Command	Brief	Field data collection system to support a multitude of mission requirements
4/8/10	FIST presentation for Pacific Endeavor	Presentation	Field data collection system to support exercises and humanitarian assistance / disaster relief
4/9/10	FIST Light concept paper	White paper	Field data collection system to support a multitude of mission requirements
5/17/10	Brief built for USMC audience	Brief	Field data collection system to support a multitude of mission requirements
6/8/10	FIST information quad	Brief	Field data collection system to support a multitude of mission requirements
6/11/10	FIST brief for AFSOC	Brief	Field data collection system to support a multitude of mission requirements
6/15/10	FIST overview brief built for SOCPAC	Brief	Field data collection system for human terrain mapping and military geography
7/15/10	FIST thesis revision 6 document	White paper	Field data collection system for multiple uses
7/23/10	Funding proposal for FIST 2011	Proposal	Field data collection system for multiple uses
7/28/10	Brief for USASOC	Brief	Field data collection system for human terrain mapping, military geography, and Village Stability Operations
7/29/10	FIST proposal for USASOC	Proposal	Field data collection system for human terrain mapping, military geography, and Village Stability Operations
8/5/10	FIST VTC brief	Brief	Field data collection system for human terrain mapping, military geography, and Village Stability Operations
8/9/10	FIST HSCB proposal to ONR	Proposal	Field data collection system for human terrain mapping and support for sociocultural dynamics collection
8/12/10	Market survey document	White paper	Field data collection system for multiple uses
8/19/10	Engagements list from PE10	Brief	Field data collection system to support exercises and humanitarian assistance / disaster relief
8/20/10	FIST USAID brief (HA/DR)	Brief	Field data collection system for humanitarian assistance and disaster relief
8/30/10	FIST brief to PACOM J4	Brief	Field data collection system for humanitarian assistance and disaster relief

Table 8.   Communication Events–Sep 2010–June 2011

Date	Event	Type	Narrative emphasis
9/20/10	FIST brief (Master document)	Brief	Field data collection system for multiple uses
9/23/10	FIST brief for ACMC	Presentation	Field data collection system for multiple uses
9/29/10	MWCG brief	Brief	Field data collection system capable of leveraging tactical communication systems
10/4/10	FIST Homeland Security Consortium Quad	Proposal	Field data collection system for counter-gang operations and law enforcement activities
10/20/10	FIST brief CAHLS	Brief	Field data collection system for counter-gang operations and law enforcement activities
10/25/10	CAHLS Budget submission	Proposal	Field data collection system for counter-gang operations and law enforcement activities
11/2/10	FIST brief which includes Afghanistan examples	Brief	Field data collection system for Village Stability Operations and human terrain mapping
11/6/10	FIST outbrief (Afghanistan) with examples	Brief	Field data collection system for Village Stability Operations and human terrain mapping
11/8/10	FIST presentation to PhD seminar	Presentation	Field data collection system for multiple uses
11/8/10	FIST executive summary outbrief	Presentation	Field data collection system for multiple uses
11/9/10	Statement of Work - CHSC	Proposal	Field data collection system for counter-gang operations and law enforcement activities
11/10/10	Kick off meeting with SOCPAC for FIST RP	Meeting	Field data collection system for sociocultural dynamics, social network analysis, and military geography
11/28/10	FIST presentation for USAID Manila	Presentation	Field data collection system for humanitarian assistance and disaster relief
12/8/10	OpenFIST proposal for CHSC	Proposal	Field data collection system for counter-gang operations and law enforcement activities
12/8/10	OpenFIST budget (CORE lab only)	Proposal	Field data collection system for counter-gang operations and law enforcement activities
12/8/10	Statement of Work - CHSC	Proposal	Field data collection system for counter-gang operations and law enforcement activities
1/3/11	OpenFIST white paper	White paper	Field data collection system for multiple uses
1/4/11	OpenFIST independent gov cost estimate	Proposal	Field data collection system for multiple uses
1/5/11	OpenFIST brief for MCIOC	Brief	Field data collection system to support target audience analysis for MISO
1/19/11	OpenFIST presentation to SOCOM-USASOC	Brief	Field data collection system for human terrain mapping, military geography, and Village Stability Operations
2/3/11	Project update for OpenFIST	White paper	Field data collection system for multiple uses
2/4/11	Project update to Intel department	Presentation	Field data collection system for multiple uses
6/1/11	Lighthouse - MEC Collaboration	White paper	Field data collection system for civil reconaissance that enables civil military operations

Table 9.   Communication Events, August 2011—April 2012

Date	Event	Type	Narrative emphasis
8/5/11	Lighthouse SOTF evaluation slides	Presentation	Field data collection system for human terrain mapping, military geography, and Village Stability Operations
8/16/11	Lighthouse brief Afghanistan	Brief	Field data collection system for human terrain mapping, military geography, and Village Stability Operations
9/1/11	JSOU Essay on Redefining Intelligence Support	White paper	Field data collection system for human terrain mapping, military geography, and Village Stability Operations
10/23/11	Lighthouse training aid for Android	Brief	Field data collection system for sociocultural dynamics, social network analysis, and military geography
10/27/11	Lighthouse brief - CORE lab	Brief	Field data collection system for sociocultural dynamics, social network analysis, and military geography
11/2/11	Lighthouse CHSC status update	Presentation	Field data collection system for counter-gang operations and law enforcement activities
12/5/11	Lighthouse update brief - CORE	Brief	Field data collection system for sociocultural dynamics, social network analysis, and military geography
12/10/11	CORE - Lighthouse MTT training (Feb 2012)	Brief	Field data collection system for sociocultural dynamics, social network analysis, and military geography
12/15/11	Lighthouse CHSC status update	Presentation	Field data collection system for counter-gang operations and law enforcement activities
4/1/12	ONR Code 30 Technical Review MARCIMS	Meeting	Field data collection system for civil reconaissance that enables civil military operations

The column listed as "narrative emphasis" in Tables 6–9 provide a more granular look at the changing narratives used to communicate the idea to various audiences. These data and the descriptive summary are now addressed in the analysis of the case.

C.   CASE ANALYSIS

Innovation is a social, interactive, and dynamic process—characterized by the exchange of knowledge and information—in which problems are defined and solutions are developed, refined, and implemented. Without a problem to solve, regardless of magnitude or difficulty, there is no need to innovate. Entrepreneurship, and more specifically public entrepreneurship, is "the generation of a novel or new idea and the design and implementation of the new idea into public sector practice" (Roberts, 1992, p. 56). The case study describes both the innovation and entrepreneurial processes to move an idea from concept into practice within the DOD.

In our previously published work (Roberts & Longley, 2013), we focused on six conditions for bottom-up innovation and entrepreneurship to be successful within large military bureaus.[16] This case study focused on three conditions—bottom-up entrepreneurship and innovation in a large public sector organization (DOD)—to interpret and analyze the consistency of an entrepreneur's ideas, team entrepreneurship, the role of entrepreneurial networks in moving an idea through the innovation process, and the central role communications of the entrepreneur play in moving an idea through the innovation process.

1. The Entrepreneur's Idea Stays Consistent through the Innovation Process

Over the course of seven years, the new idea was known by a variety of names—HTACS, MIST, FIST, OpenFIST, and Lighthouse. Each of these names was used during distinct periods of time to brand a concept. While the branding or "project name" changed over time, the concept behind the brand remained consistent throughout the innovation process. Except for the initial idea that aimed to use mobile devices over tactical hybrid networks (an idea that was quickly dismissed), the core idea for a mobile field data collection system to support sociocultural analysis persisted from mid-2009 until the transition of Lighthouse into the MARCIMS PoR.

During the initial idea development, the emphasis on human terrain collection was evident in the original concept name of HTACS—the Human Terrain Analysis Collection System. The briefings during CRIMSON VIPER 09 and subsequent collaboration with the CORE Lab refined the need for both a field collection system and the requirement to structure data collected from the field to support advanced analytics. With the rebranding of HTACS to MIST (a rebranding that occurred to soften the image evoked when describing the idea to various audiences), the core idea remained the same. Due to

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[16] The six conditions identified were "entrepreneurial problem solvers, new ideas, collective entrepreneurship; start-up resources; incubators of innovation; and idea champions" (Roberts & Longley, 2011).

confusion when briefing embassy staffs on the concept,[17] MIST was rebranded as FIST—little else changed.

After the introduction of an open-source prototype of FIST (what I called FIST-Light), the briefings and field experiments continued to focus on structured data collection to support analysis throughout the PACOM exercises as well as the field experiments in Afghanistan to support VSO.

Following the FIST experiments in Afghanistan, the concept name was rebranded due to the entrepreneurial team dissolving[18] and the short-lived OpenFIST name was used in communications for about three months' time. Finally, the OpenFIST name was replaced with Lighthouse—the name that would remain until the conclusion of the project. Each name change was deliberate and purposeful, but the idea that the name represented remained consistent throughout the innovation process.

In contrast to the case studies described in Schroeder et al (1989), the new idea did not splinter into several different divergent paths of ideas. In fact, the opposite occurred. The entrepreneur's new idea, while communicated using different project names, remained consistent throughout the innovation process.

2.   Entrepreneurship Is a Team Sport

While an entrepreneur is commonly found at the forefront of ensuring an innovation is moved into accepted practice within public sector organizations (Roberts, 1992; Heinonen, 2001; Zerbinati & Souitaris, 2005; Roberts, 2006; Roberts, 2010; Westrup, 2013), entrepreneurs can be "individuals, or groups of individuals" who enable innovation within an organization (Sharma & Chrisman, 2007).

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[17] Military Information Support Teams (MISTs) work in US Embassies throughout the world providing psychological operations planning and support.

[18] The entrepreneurial team prior to dissolution was a collaboration between me (the lead entrepreneur), members of the CORE Lab, Kestrel Technology Group, and Alan Yann at NPS Pacific. Following the team dissolution, the entrepreneurial team was comprised of the lead entrepreneur and members of the CORE Lab and Chief Frank at 10th Special Forces Group.

Although I played a significant role the ideation and management of the new idea over time as the lead entrepreneur, the new idea would never have transitioned into the MARCIMS PoR without the help of a significant number of people. The field data collection concept was refined, tested, tweaked, employed, communicated, and championed by numerous individuals and organizations. From the initial ideation with Dr. Nancy Roberts and CWO3 Frank, to the coordination with key individuals in the MEC, the mobile data collection system known as Lighthouse existed and was successful due to the efforts of an entrepreneurial team, and not the sole entrepreneur.

Entrepreneurship is a team sport. The success of the Lighthouse project and the movement of the new idea through the innovation process was a team rather than individual achievement. Team entrepreneurship eschews the notion that innovation is the work of a sole individual, and instead points to the reality that entrepreneurship is a result of a myriad of individuals, working in concert with each other, to incrementally evolve ideas and develop solutions to problems (Reich, 1987). Within this study, the actions of the lead entrepreneur, a core group of individuals who formed the entrepreneurial team (Dr. Nancy Roberts, Chief Frank, and I), and an extended network of supporters enabled the mobile data collection idea to move from concept into implementation. The actions described in the case can best be viewed through the lens of team entrepreneurship, embedded in an organization, where action is governed by "rules, norms, routines, cognitive scripts, and discourses that structure the actions of the social and political actors and create patterns of interaction" (Sørensen & Torfing, 2011, p. 860).

3. The Entrepreneur's Network Is Central in Gaining Acceptance for the Idea and Moving it through the Innovation Process

As a continuation to the previous observation about team entrepreneurship, a core group of individuals who supported, communicated, and drove the new idea throughout the innovation process were instrumental in the idea's success. Innovation studies must consider the role of management in the innovation process (Van de Ven, 1986), and more specifically the act of managing ideas (Schroeder et al., 1989; Flynn, Dooley, O'sullivan, & Cormican, 2003; Du Preez & Louw, 2008; Alexe et al., 2014) in moving ideas from conception into practice. Entrepreneurial activity is not a singular action, but rather a

"network building effort" focused on sustained, purposeful, and deliberate activity to implement an innovation (Van de Ven, 1986).

A network of individuals within the CORE Lab, DA department, NPS Pacific, commercial partners, government research organizations, and military units were involved in gaining acceptance for the idea and enabling the idea to move through the innovation process. Within this larger network of individuals and organizations, an entrepreneurial team[19] with close relationships and frequent interactions enabled the idea to be communicated across traditional hierarchical boundaries within the DOD. As a research hub home to students and faculty across the different services within the DOD, the NPS was uniquely positioned as a crossroads within the organization. As the idea gained traction among a core group of supporters, the entrepreneurial team could present the new idea to decision makers at every echelon of command across major components of the DOD with relative ease. This unique "position" within the DOD enabled the entrepreneurial team to leverage connections through their social networks throughout the DOD to spread information about the idea and garner support much faster than would have been possible in a "traditional" unit within the DOD.

4. Communication—Both Internal among an Entrepreneurial Team and External to a Network of Supporters—Played a Central Role in the Entrepreneurial Process

The literature is replete with examples of communication being critical to the success of innovation (Lazer & Friedman (2007); Wellman, Salaff, Dimitrova, Garton, Gulia, & Haythornthwaite, 1996) and Rogers' Diffusion of Innovation theory is defined by the spread of ideas "via certain communication channels over time among the members of a social system" (Rogers, 2010, p. 11). Whereas these studies focus on the communication of ideas external to the entrepreneurial network, the communication within and amongst the network members is just as critical.

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[19] As previously mentioned the entrepreneurially team varied in composition over time. As referenced in this section, the entrepreneurial team was primarily composed of Dr. Nancy Roberts, Chief Frank, and me, the lead entrepreneur.

Interpretive governance theory provides a framework for understanding the actions of an entrepreneur, embedded in a network of relations within an organization, to move an idea into practice. Interpretive governance theory (Bevir & Rhodes, 2006; Bevir & Richards, 2009) suggests that innovation research should focus on the "individual actors and the meanings that they are constructing and acting upon" (Osborne & Browne, 2013, p. 311). This social construction of meaning is at the heart of the theory on Collective Management of Meaning (Pearce & Cronen, 1980) and was observed repeatedly during external communications.

Communications of the idea to different individuals and organizations within the extended entrepreneurial network took two forms—coordination of activities related to the design and development of the idea, and communication to garner support for the idea. Internal communications—those defined by coordination within the immediate entrepreneurial team—focused on refining the mobile data collection platform and often emphasized the technical and logistical challenges faced when developing and testing prototype designs of the idea. External communication of the idea was focused on garnering support for the idea. During these exchanges, I would often present the idea within a context that would resonate with different target audiences. Discussions with Marine audiences would emphasize the maritime and civil reconnaissance applications of the idea whereas engagements with SOF personnel would emphasize the use of the tool in COIN environments. Similarly, discussions with law enforcement groups would highlight the application of the mobile collection system for counter-gang operations. During each of these exchanges, I would engage with individuals and manage the presentation of the idea in such a way as to attempt to maximize the audience interest and increase the likelihood of support.

D.   INSIGHTS ON THE MANAGEMENT OF NEW IDEAS

In previous research, Roberts and Longley (2013) identified six conditions for bottom-up innovation and entrepreneurship to be successful in the DOD. In this case analysis, I have focused on three conditions for bottom-up innovation and

entrepreneurship and have placed my focus on a deeper probing of the management of ideas by entrepreneurs through the innovation process.

I now present two insights generated related to the management of the idea's identity and meaning that I will first discuss, and subsequently probe in greater depth in the following chapter. Both insights are founded on the belief that an entrepreneurial team's actions to carefully manage the core idea and the communication of the idea through different narratives were critical to the success of the field data collection concept within the DOD. These two insights are of interest since the literature does not address the entrepreneur's perspective in the management of ideas.

a.   *Insight 1: The Core Idea of the Innovation Remains Constant*

The central idea of a mobile field data collection system remains constant and consistent throughout the innovation process. The management of this central idea was largely due to the lead entrepreneurs' desire and actions to ensure the initial motivations behind field data collection and information gaps were addressed. The management of the idea from concept to implementation was in large part due to the efforts of the entrepreneur and his team in moving an idea through the innovation process.

In the case description, I provided a longitudinal description of the efforts of an entrepreneur and his team in creating the initial idea based on a perceived gap in the current organizational capabilities in moving information about a battlefield. This initial motivation, coupled with the refinements and partnerships established early in the process, firmly established a core concept that held firm for the remainder of the time. This core idea—a mobile field collection tool to support analysis—remained at the forefront of all discussions and engagements from early 2009 to mid-2016.

Despite project setbacks and changes over time, the entrepreneur and his team protected the central idea and managed both the development and the communication of the idea as he worked to move the idea into practice. When threatened with competing views of the idea (i.e., the commercialization of the idea into a knowledge management system vis-à-vis Kestrel), the entrepreneurial team worked to protect the modifications of

the idea and even split with the commercial partnership to ensure the idea remained unchanged.

<i>b. Insight 2: Narratives Shift over Time as the Entrepreneurial Team Reframes the New Idea in Terms that are Attractive to Different Audiences</i>

The second insight concerns the shift in narratives required to describe the idea to influence and persuade different audiences. By providing different contextually based descriptions of the innovation, it was our aim to increase the attractiveness of the idea and the applicability to different end users.

Throughout the course of the case, I provided several examples of a change in the presentation of the idea (i.e., narratives) to different audiences to better align the interpretation of the core idea with individual and organizational needs to build support for the concept. These narratives were captured in the description of the mobile data collection system to support VSO in Afghanistan, to serve as a field data collection system to facilitate humanitarian and exercise support requirements, to serve as a tool to be used in Special Forces training (ROBIN SAGE), to support law enforcement requirements on the streets of California and Massachusetts, and finally to enable civil military operations in the Marine Corps.

Each of these narratives modified the application and context of the idea, but not the central idea itself. The degree to which the narratives resonated with the audiences and were successful in obtaining operational sponsorship and resourcing varied, but the sponsorship and funding provide by SOCPAC, the California Homeland Security Consortium (CHSC) and finally MARCIMS enabled the project to persist and move through the innovation process.

Setting aside the discussion of the innovation process for a moment, the second insight generated in this study appears to merely confirm a prevailing view about communications. Indeed, it is a commonly accepted generality that individuals alter their communications to different audiences to increase the attractiveness of an idea. While

this insight may be unsurprising and is often taken for granted, this study provides evidence to support this view within the context of entrepreneurship and innovation.

E.   CHAPTER SUMMARY

This chapter describes the case history of a new idea—a mobile field data collection system to enable sociocultural analysis—and its initiation, design, and implementation within an organizational setting. The case also documents the entrepreneur's efforts and those of the entrepreneurial team to shepherd the idea through its many iterations into DOD practice. The case analysis surfaces two insights of interest with regards to the management of ideas that alter the dominant view held within the innovation literature. Thus, Chapter V conducts additional analysis on these two propositions to test whether they hold up to quantitative scrutiny.

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V.   QUANTITATIVE ANALYSIS

A.   INTRODUCTION

In Chapter IV, I presented a case study that tracks the evolution of an idea evolution over time and the entrepreneurial activities required to move the idea from idea generation to product implementation. As the lead entrepreneur managing the new idea—the development of a handheld data collection tool to support sociocultural analysis—through the innovation process, I generated two insights about the stability of the core idea and the changing narratives used to frame the idea in terms that audiences would find attractive.

This chapter explores in greater depth the two insights I have drawn from the case study and uses three different, but related, analytic techniques to examine these insights empirically. Recall from the research strategy, the quantitative analysis in this chapter takes as inputs the two insights I generated from the case study. These two insights are now tested empirically. The way in which this chapter nests within the larger framework of inquiry for this study is shown in Figure 11.

Research Strategy

1. *How do ideas develop and evolve over time as they move through the innovation process?*

2. *How do entrepreneurs manage the meaning of an idea as it evolves over time?*

Literature review	Case Study	Quantitative Analysis	Findings
	Conditions: • Public sector • DoD • Bottom-up (micro)	**Inputs:** • *Insights* generated from case study	

Innovation process *unit of analysis: the idea* **Entrepreneurial process** *unit of analysis:* entrepreneur's activities in managing and moving an idea through the innovation process **Innovation Entrepreneurship Management of Ideas**	**Entrepreneur's experiences, lived reality, and *initial idea*** Archival Records Case development and evolution of the idea	Archival Records **Semantic Network Analysis** + **Topic Modeling** + **Lexical Analysis**	**Insights from Case Study** + **Findings from Quantitative Analysis**

Focus:	**Outputs:**	**Outputs:**	**Outputs:**
• Interconnection of innovation and entrepreneurship • Management of ideas, • Confounding of *units of analysis* • The absence of *differentiation* between levels of analysis	Two *insights* about the management of ideas *1. The core idea of the innovation remains constant* *2. Narratives shift over time to reframe the idea to garner support*	• Quantitative analysis of the *communication of the idea* • Evidence supporting the insights identified in the case study (qualitative analysis)	• Two propositions generated about the management of ideas • Refined model of entrepreneurship • Contributions of study

Figure 11.   Research Strategy–Quantitative Analysis Inputs and Outputs

The analysis I present in this chapter is focused on the communication of the new idea—both the core idea and its narratives—over time by an entrepreneur and his team. More specifically, the analysis in this chapter focuses on the words used to communicate and describe the new idea to different audiences. As both insights generated from the case analysis are connected to the act of communicating idea, they are examined simultaneously using each analytic method. After each method, I interpret the findings

from each method before providing a synthesized summary of all three methods at the end of the chapter.

The quantitative analysis combines multiple methods to analyze the archival records related to the communications describing the idea. I employ semantic network analysis, topic modeling, and lexical analysis to test both propositions about the communication of the new idea against the archival records from the case. These records include presentations, briefings, white papers, email correspondence, funding proposals, and project plans used to communicate the idea to different audiences over time.[20]

Before proceeding with the analysis, the subsequent section describes the process used to structure and bin the data into discreet time periods prior to moving in the three different analytic approaches described.

1.   Data Structuring

The archival records represent the corpus of documents used to communicate the idea to both internal and external audiences from February 2009–October 2012. Within these documents, I extracted the text content of briefings, minute notes, essays, white papers, emails, and other text documents first by organizing the data by month. These data were then consolidated into 15, three-month time periods (Table 10).

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[20] Of note, the archival records include briefings given about the idea to different audiences. These briefs were developed both by the lead entrepreneur and by individuals within the entrepreneurial team. Thus, the analysis of the records captures both my communication and narrative as well as the communication and narrative of the entrepreneurial team.

Table 10.   Time Periods for Data Analysis

Period	Dates Covered
1	Feb, Mar, Apr–2009
2	May, Jun, Jul–2009
3	Aug, Sep, Oct–2009
4	Nov, Dec–2009, Jan–2010
5	Feb, Mar, Apr–2010
6	May, Jun, Jul–2010
7	Aug, Sep, Oct–2010
8	Nov, Dec–2010, Jan–2011
9	Feb, Mar, Apr–2011
10	May, Jun, Jul–2011
11	Aug, Sep, Oct–2011
12	Nov, Dec–2011, Jan–2012
13	Feb, Mar, Apr–2012
14	May, Jun, Jul–2012
15	Aug, Sep, Oct–2012

The binning approach I chose was done to normalize the data set into equal time periods in an attempt at minimizing the vast fluctuations in archival records from month to month.[21] As an example, in some months very few documents or emails existed due to low communications volume (summer breaks, travelling, etc.). The following month, a much higher volume of communication occurred. If two months were compared with this significant change in volume, concepts in a low-volume month would appear to be more significant than they were and high-volume months would reduce the impact of key documents highlighting a semantic shift. To compensate for this variance, a three-month slice was chosen which resulted in 15 separate time periods.

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[21] Semantic network analysis is more sensitive to varying network sizes (time periods) than is topic modeling or lexical analysis. Using weighted or proportional counts and term frequency inverse document frequency (TF-IDF) approaches, the effects of varying document sizes have less of an impact than varying network sizes may have on network analysis.

2.   Analytic Approach

I begin the chapter with semantic network analysis the purpose of which is to identify core concepts (words) in the archival records. Said another way, the semantic analysis is used to identify the terms that were used to describe the new idea. These core concepts should correspond to the central components of the new idea and closely mirror the central concepts presented in the case. As semantic network analysis generates links between nodes based on proximity within the text, key nodes (i.e., words) can be identified quickly using standard centrality measures. Words scoring highly on degree, betweenness, and eigenvector centrality are deemed to be "important" to the network. Thus, nodes that are score highly on centrality measures in a semantic network should correlate to important concepts describing the new idea. In addition to standard centrality metrics, I have adopted the semantic typology from Carley and Kaufer (1993) discussed earlier to further refine "important" concepts within the semantic networks using a communicative power analysis. A communicative power analysis extends beyond simple centrality measures to not only identify key nodes, but it also provides additional insights for terms that would not normally appear based solely on centrality measures. Finally, I conclude the semantic network analysis by applying the Clauset, Newman, and Moore (2004) community detection algorithm to identify clusters of nodes within the semantic networks to identify the core themes of the semantic networks. The clusters identified in each period should represent the dominant words (i.e., narratives) used to describe the idea to external audiences.

Following the semantic network analysis, I incorporate an altogether different approach to analyzing the text—topic modeling. Topic modeling provides a means to analyze large volumes of unstructured text to identify clusters of words that frequently appear together within the text. Topics are generated from documents and topics are compared over time by studying the contribution of each document to the entire corpus. In effect, the topic modeling applied in this chapter is used to identify the degree of change of clusters of words over time. Whereas the semantic network analysis aimed to identify key words (nodes), the topic modeling approach aimed to identify key clusters of

words (topics) and track the change over time. The topics are best described as a group of words used to describe the new idea in each period.

Finally, I conclude the analysis in this chapter by using Lexos[22] to apply three lexical analysis techniques: document similarity comparisons, statistical modeling to identify terms of significance, and the generation of visualizations to detect clustering among documents in the corpus. These techniques have the explicit purpose of identifying document similarity over time from the corpus. In other words, how much did the idea change over time? High levels of document similarity over time suggest a significant amount of semantic overlap, whereas low levels of similarity and clustering suggest a low level of semantic similarity—that is, the core description of the new idea is drastically different.

In summary, I have combined three different text analytic approaches to analyze the archival records for the new idea. From the identification of key nodes to the statistical comparison of documents within the corpus, my intent is to explore how the new idea was managed by the entrepreneur over time as it was moved through the innovation process.

B.   SEMANTIC NETWORK ANALYSIS

Turning now to the semantic network analysis of the archival records, I present a discussion on the network visualizations of the archival records before transitioning into an analysis of the core network. Following the core network discussion, I conduct a communicative power analysis and analyze the archival records according to 8 different semantic typologies. Finally, I present the findings from a community detection analysis of the semantic networks.

1.   Network Visualizations

The following section presents the semantic network visualizations by time. First, I will highlight the complete network sociograms by period. Because of the sheer size of

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[22] More information about Lexos can be found by visiting their website–
https://github.com/WheatonCS/Lexos.

these sociograms, I have removed the labels as the network size makes most time periods unintelligible. Due to the network sizes and visual complexity, the semantic analysis that follows will refrain from using additional visualizations of the networks.

The following sociograms highlight the semantic network by period. Due to their size (and lack of labels), I have included four time periods per figure. While it is difficult (if not impossible) to identify core concepts and themes from the visualizations alone, the complexity and density of the graphs in each period do provide some insights. Figures 12, 13, 14, and 15 include the network visualizations for each period in this analysis. Based on visual inspection, one can see that the average degree,[23] number of links, and node count varies over time. Given that these network diagrams are representative of the concepts and words used to describe the new idea, the increasingly complex and dense networks in later time periods are reflective of the multiple narratives used to describe the new idea to different audiences for different purposes. In the initial periods, the new idea was described in simple, hypothetical terms. Over time, the narratives surrounding the idea increased as the idea was pitched to different audiences for different purposes. At the beginning of the ideation, there were few communications and archival records, as the new idea was just beginning to take shape.

In the middle of the period we see the densest networks which correspond to an increased volume of communication activity—briefs, emails, papers—which correspond to the height of activity for the project. Finally, as I moved into a supporting and finally observer role of the new idea, my involvement and thus access to material used to communicate the idea diminished. As I changed roles from lead entrepreneur to simply an observer, the locus of control and management of the idea was no longer mine to shape and control. Upon turning over the project reigns to an entrepreneurial team in Monterey and in Hawaii in mid-2012, I no longer could manage, shape, and control the description and communication of the new idea any longer—I could only observe the process unfold.

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[23] The average degree for each period is as follows: 1–0.00500; 2–0.00100; 3–0.00048; 4–0.00038; 5–0.00012; 6–0.00092; 7–0.00013; 8–0.00007; 9–0.00042; 10–0.00096; 11–0.00078; 12–0.00060; 13–0.00027; 14–0.00200; 15–0.00400.
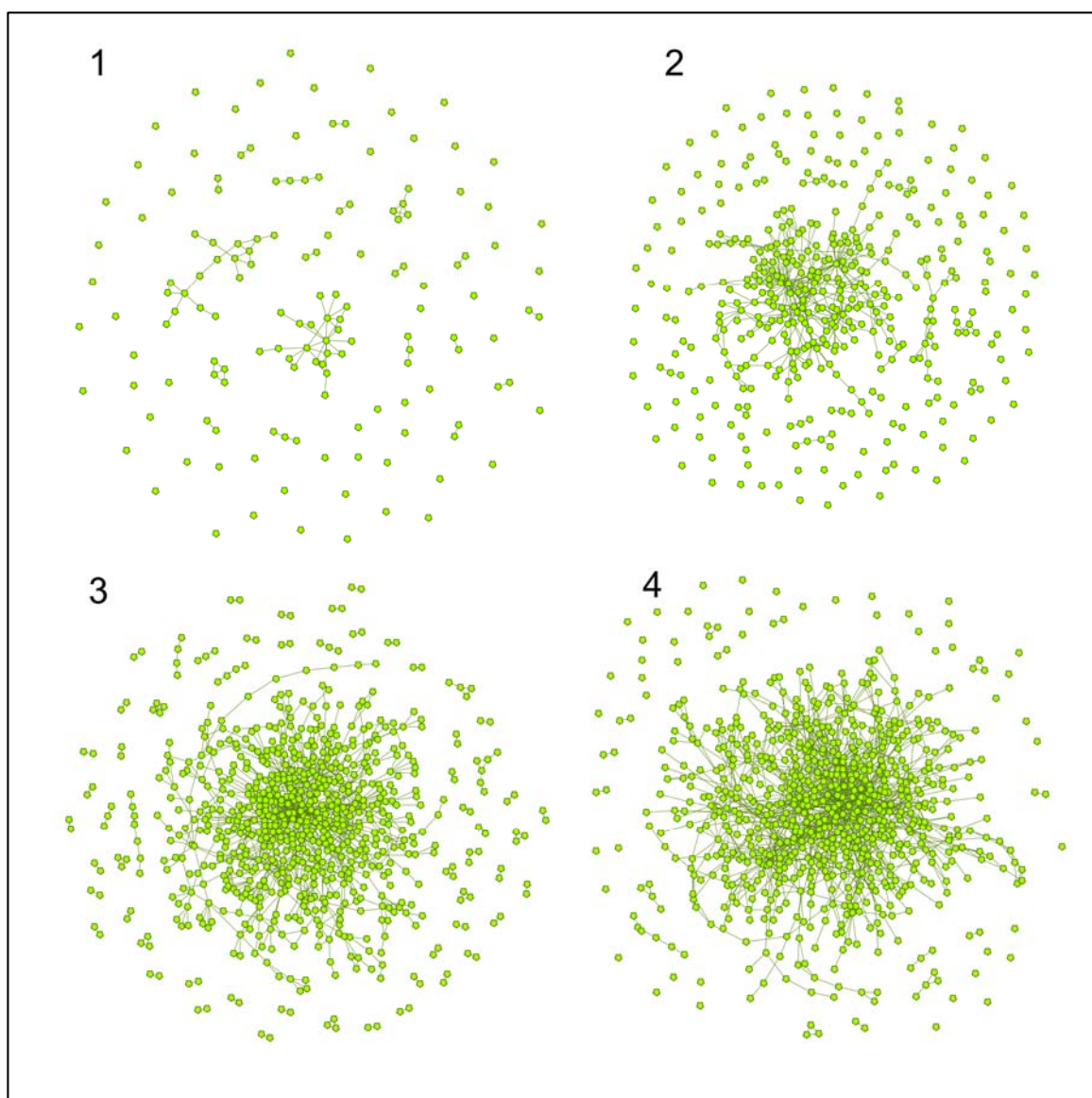
Figure 12.   Semantic Network Visualizations–Periods 1–4
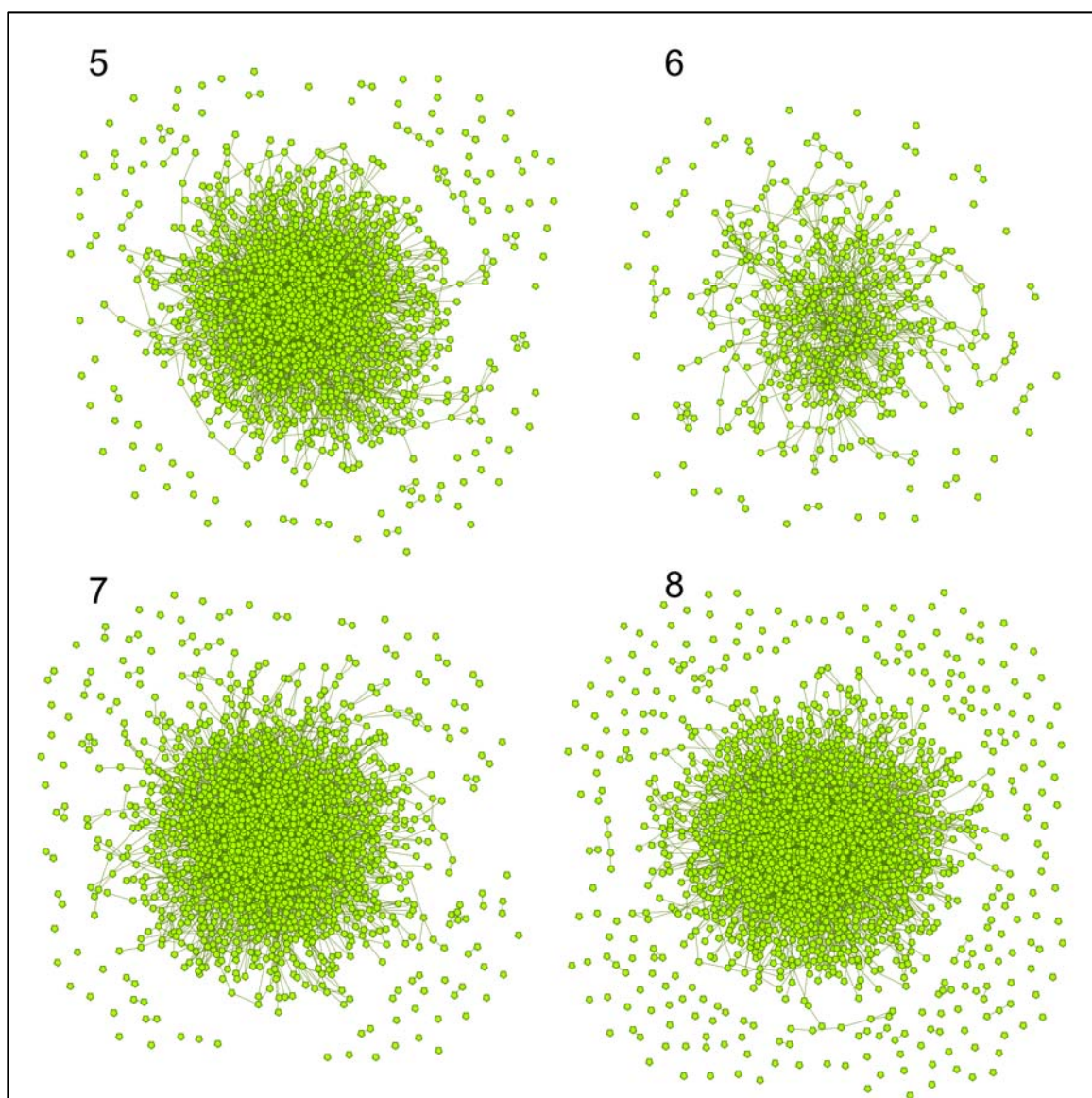
Figure 13.   Semantic Network Visualizations–Periods 5–8

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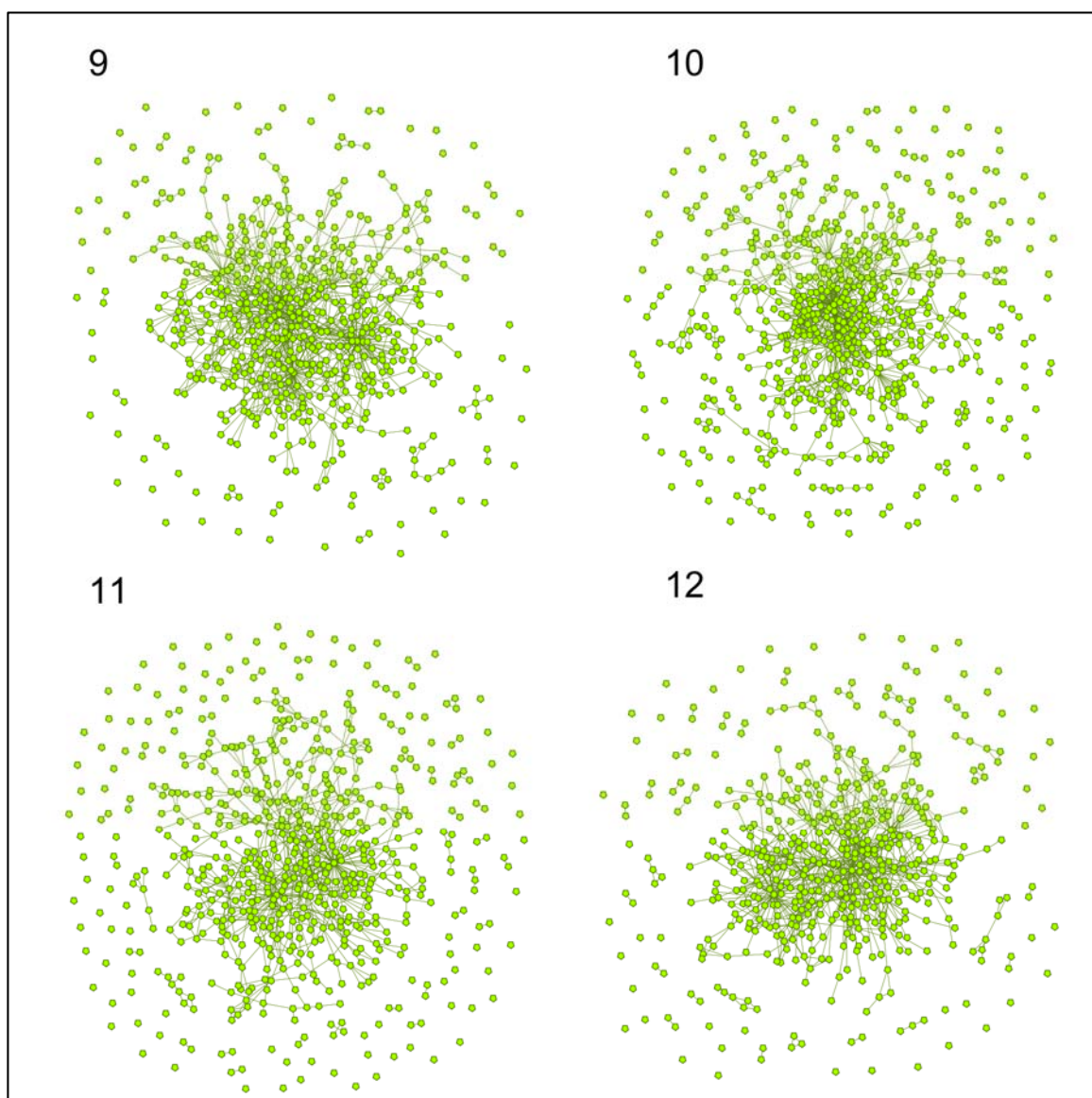
Figure 14.   Semantic Network Visualizations–Periods 9–12
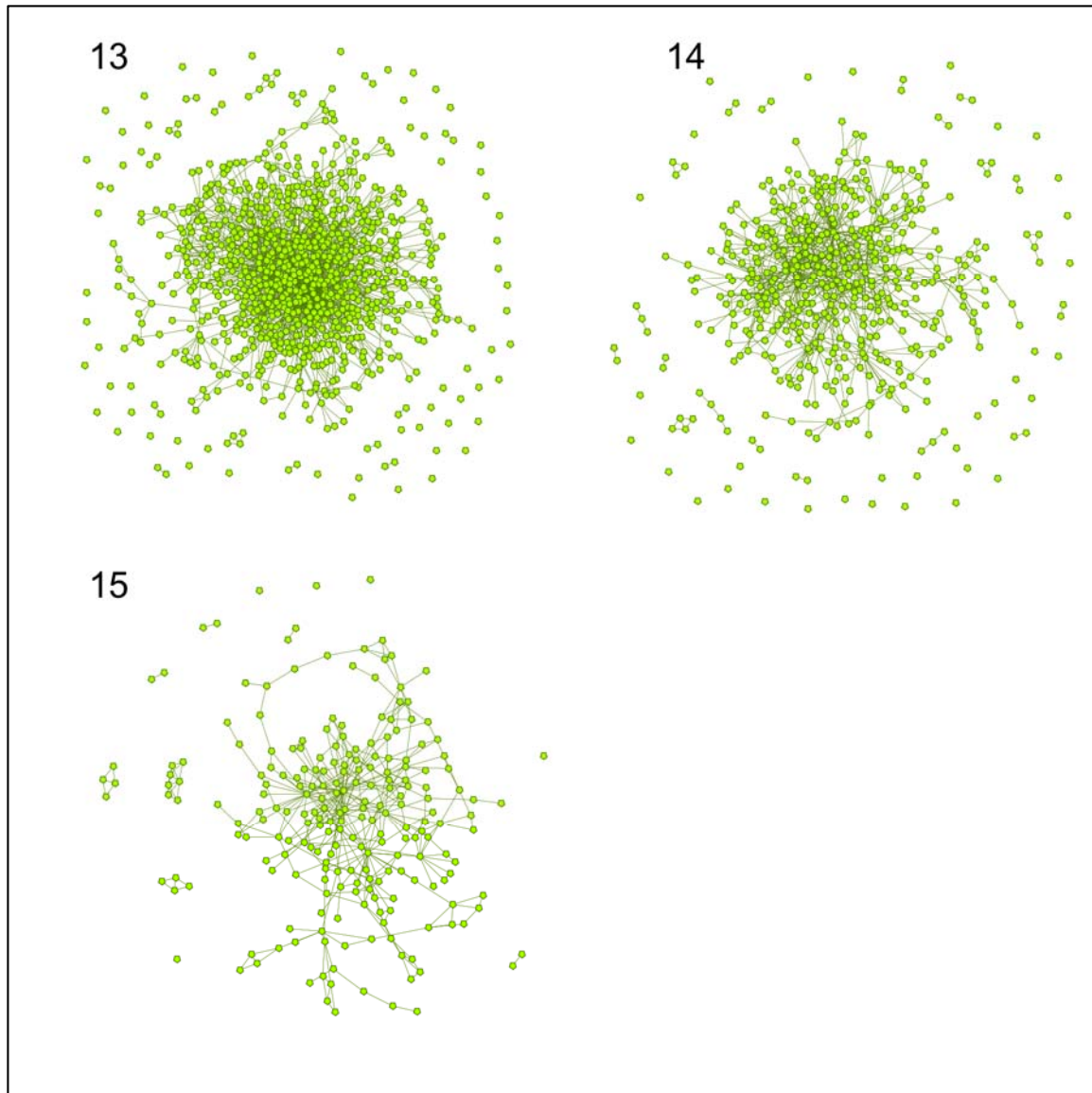
Figure 15.   Semantic Network Visualizations–Periods 13–15

2.   Core Network–Key Nodes

Having now conducted a cursory inspection of the semantic network sociograms, the true value of semantic network analysis can be unlocked by reviewing a core network analysis of the semantic networks. The core network report generates a few key pieces of information that inform subsequent analytic procedures. In this section, the core network analysis can best be understood and interpreted as the core description of the new idea. In

this section, the primary nodes and relationships identified in the core network analysis unveil the central ideas behind the new idea.

In the core network analysis, ORA takes a social network input and calculates the number of entities and density in the entire network, and then recursively removes pendants and isolates to arrive at the core network measure. In addition, the core network report calculates the top 10 nodes scoring highest in terms of degree and betweenness centrality. These nodes are identified with a scored value, an unscaled value, and an estimated context score, which equals the number of standard deviations from the mean of a random network of the same size and density. Recall from the semantic typology introduced earlier, degree centrality corresponds to density and betweenness centrality corresponds to conductivity. In addition to the two centrality measures automatically generated by ORA, I have included a third centrality measure—eigenvector—as a means of comparison. Eigenvector centrality considers a node to be central only when it has ties to other central nodes. To extend this idea to a semantic network, a node scoring high in terms of eigenvector centrality should be representative of words that are closely related to other important words within a given period. For the other two measures of centrality, concepts scoring highly on degree centrality in the core network analysis indicate nodes that have the most number of relational ties within the graph. This centrality indicates importance rather than simply appearing in a text most often (frequency count). The central concepts are tied to many other concepts in a document. Similarly, the concepts scoring highly with betweenness centrality lie on the shortest path between other concepts.

In Table 11, which reports scores from the first period, *data* scores the highest on all three measures of centrality—a pattern that is repeated throughout the periods. Given that the new idea was described as "field data collection tool using mobile technology to collect sociocultural data for relational analysis," it should not be a surprise then that many of the words in that phrase appear in each of the centrality tables.

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Table 11. Core Network–Period 1

Time Period	1	
	Entire Network	**Core Network**
Number of entities	146	83
Average Degree	0.005	-

Degree Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.018	42	1.427
2	collect	0.01	24	0.358
3	sna	0.009	22	0.239
4	thesis	0.008	18	0.002
5	core	0.007	16	-0.117
5	cultural	0.007	16	-0.117
5	export	0.007	16	-0.117
5	lab	0.007	16	-0.117
6	behavioral	0.006	14	-0.236
6	intel	0.006	14	-0.236
6	iw	0.006	14	-0.236
6	sciences	0.006	14	-0.236
6	terrain	0.006	14	-0.236
7	dissimenate	0.005	12	-0.355
7	marine	0.005	12	-0.355
7	program	0.005	12	-0.355
8	collection	0.003	8	-0.592
8	geographic	0.003	8	-0.592
8	handheld	0.003	8	-0.592
8	io	0.003	8	-0.592
8	legs	0.003	8	-0.592
8	marsof	0.003	8	-0.592
8	mcwl	0.003	8	-0.592
8	metrics	0.003	8	-0.592
8	process	0.003	8	-0.592
8	requirement	0.003	8	-0.592
8	socio-cultural	0.003	8	-0.592
9	applications	0.003	6	-0.711
9	corp	0.003	6	-0.711
9	corps	0.003	6	-0.711
9	formats	0.003	6	-0.711
9	prototyping	0.003	6	-0.711
10	analyze	0.002	4	-0.83
10	bytes	0.002	4	-0.83
10	commercial	0.002	4	-0.83
10	complex	0.002	4	-0.83
10	concept	0.002	4	-0.83
10	excel	0.002	4	-0.83
10	execute	0.002	4	-0.83
10	exercises	0.002	4	-0.83
10	for_example	0.002	4	-0.83
10	generate	0.002	4	-0.83
10	ghostnet	0.002	4	-0.83
10	htn	0.002	4	-0.83
10	map	0.002	4	-0.83
10	marcorsyscom	0.002	4	-0.83
10	marcosyscom	0.002	4	-0.83
10	mccdc	0.002	4	-0.83
10	meu	0.002	4	-0.83
10	network	0.002	4	-0.83
10	networks	0.002	4	-0.83
10	observation	0.002	4	-0.83
10	technical	0.002	4	-0.83
10	zip	0.002	4	-0.83

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.012	121.5	-0.294
2	collect	0.009	92.167	-0.344
3	sna	0.008	82	-0.362
4	thesis	0.007	78	-0.369
5	program	0.007	72	-0.379
5	sciences	0.007	72	-0.379
6	cultural	0.007	70	-0.382
6	iw	0.007	70	-0.382
7	intel	0.004	44	-0.427
8	exercises	0.003	29.833	-0.451
9	formats	0.002	20	-0.468
9	networks	0.002	20	-0.468
9	terrain	0.002	20	-0.468
10	collection	0.002	19	-0.47

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.224	0.158	-3.952
2	sciences	0.147	0.104	-4.263
3	behavioral	0.14	0.099	-4.293
4	cultural	0.136	0.096	-4.31
5	sna	0.135	0.095	-4.314
6	terrain	0.122	0.087	-4.363
7	collect	0.114	0.08	-4.398
8	export	0.113	0.08	-4.402
9	program	0.098	0.07	-4.46
10	iw	0.095	0.067	-4.475

* Number of standard deviations from the mean of a random network of the same size and density

A description of the new idea as "a handheld collection device to collect socio-cultural intelligence for social network analysis" can be generated using concepts in

Table 11 alone. This description closely mirrors the description of the idea used throughout the case study and presented in the introduction of the dissertation.

In Table 12, which reports scores from period 2, we see the emergence of terms (narratives) used to describe the new idea such as *handheld*, *devices, ethnographic, intelligence,* and *scd (*short for "sociocultural dynamics"), while at the same time we continue to see the core ideas of *data*, *network*, and *collection* all remaining in the top three scores for centrality metrics. By using only terms identified in each of these tables, one can describe the new idea by merely reading down each column. As an example, the following phrase could be generated from the terms in the degree centrality alone— "The *handheld project* uses *applications* running on *iPhones*, *iPods*, and other *devices* to enable *data collection* for *ethnographic intelligence,* sociocultural dynamics (*scd*), and other *applications."* This synthetic sentence could have easily appeared in any one of our briefings focused on human terrain mapping.

Table 12. Core Network–Period 2

Time Period	2	
	Entire Network	**Core Network**
Number of entities	414	309
Average Degree	0.001	-

Degree Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.016	94	3.272
2	network	0.01	58	1.469
3	collection	0.009	52	1.168
4	iphone	0.006	36	0.367
4	ipod	0.006	36	0.367
4	project	0.006	36	0.367
5	devices	0.006	34	0.267
6	terrain	0.006	32	0.166
6	touch	0.006	32	0.166
7	htacs	0.004	22	-0.334
7	thesis	0.004	22	-0.334
8	core	0.003	20	-0.435
8	technical	0.003	20	-0.435
9	application	0.003	18	-0.535
9	commercially	0.003	18	-0.535
10	cultural	0.003	16	-0.635
10	ethnographic	0.003	16	-0.635
10	gathering	0.003	16	-0.635
10	handheld	0.003	16	-0.635
10	intelligence	0.003	16	-0.635
10	scd	0.003	16	-0.635

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.125	10619.84	0.938
2	network	0.111	9474.512	0.829
3	commercially	0.043	3636.58	0.27
4	handheld	0.031	2644.048	0.175
5	iphone	0.029	2456.467	0.157
6	devices	0.029	2450.268	0.156
7	collection	0.027	2281.937	0.14
8	project	0.027	2280.525	0.14
9	thesis	0.026	2174.63	0.13
10	technical	0.025	2119.874	0.124

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	collection	0.559	0.395	1.296
2	data	0.524	0.37	1.097
3	terrain	0.352	0.249	0.119
4	gathering	0.167	0.118	-0.93
5	capability	0.142	0.1	-1.074
6	intelligence	0.134	0.095	-1.116
7	dissemination	0.133	0.094	-1.126
8	handheld	0.114	0.081	-1.23
9	aggregation	0.1	0.071	-1.311
10	ethnographic	0.099	0.07	-1.315

In Table 13 (period 3), we see the emergence of the terms *mist* and *mistmg*—two names used to describe the MIST project which was a specific branding given to the project name for the new idea. In addition to the repeat high ranking concepts of *data*, *collect*, and *analysis*, the emergence of *coin* indicates a context in which the new idea was often framed—a tool to support Counter-insurgency Operations (COIN).

Table 13.   Core Network–Period 3

Time Period	3			
	Entire Network	**Core Network**		
Number of entities	896	454		
Average Degree	0.00048	-		

Degree Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.013	304	5.504
2	collection	0.007	166	2.26
3	mist	0.006	128	1.367
4	mist-mg	0.005	122	1.225
5	application	0.005	112	0.99
6	project	0.004	92	0.52
7	held	0.003	72	0.05
8	cellular	0.003	70	0.003
8	coin	0.003	70	0.003
8	report	0.003	70	0.003
9	hand	0.003	66	-0.091
9	multimodal	0.003	66	-0.091
10	suite	0.003	64	-0.138

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.251	100602	0.722
2	terrain	0.05	19994.77	0.135
3	collection	0.05	19816.46	0.134
4	arcgis	0.048	19071.63	0.128
5	application	0.045	18165.06	0.122
6	iphone	0.042	16727.79	0.111
7	developing	0.04	16144.68	0.107
8	program	0.036	14309.11	0.094
9	created	0.034	13700.47	0.089
10	mist	0.032	12656.03	0.082

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.417	0.295	0.085
2	collection	0.389	0.275	-0.096
3	mist	0.342	0.242	-0.401
4	held	0.284	0.201	-0.783
5	application	0.277	0.196	-0.827
6	report	0.267	0.189	-0.893
7	hand	0.259	0.183	-0.94
8	mist-mg	0.259	0.183	-0.946
9	multimodal	0.251	0.178	-0.992
10	project	0.251	0.178	-0.994

* Number of standard deviations from the mean of a random network of the same size and density

Table 14 (period 4) includes the emergence of *irapids* and *thai* into central nodes within the network. During this period, the new idea was squarely being implemented within the framework of technology developed by Kestrel Technology Group which included their iRapids system. Additionally, the first application of the new idea in practice occurred in Thailand. *Data*, *collection*, and *relationship* all still appear as central nodes, but this period also reflects a shift in the narrative with more emphasis being placed on *geography* than on *sociocultural* as was seen in Table 14.

Table 14.   Core Network–Period 4

Time Period	4	
	Entire Network	**Core Network**
Number of entities	759	526
Average Degree	0.00038	-

Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.01	250	1.984
2	moe	0.005	126	0.056
3	irapids	0.004	112	-0.161
4	subset	0.004	110	-0.193
5	collection	0.003	70	-0.815
6	geography	0.003	66	-0.877
7	affairs	0.002	64	-0.908
7	application	0.002	64	-0.908
8	relationship	0.002	62	-0.939
9	concept	0.002	56	-1.032
10	project	0.002	54	-1.063
10	toc	0.002	54	-1.063

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.215	61592.33	0.958
2	application	0.079	22524.72	0.338
3	example	0.071	20417.85	0.304
4	collection	0.07	19994.93	0.298
5	geography	0.063	18044.27	0.267
6	thai	0.06	17152.19	0.252
7	relationship	0.049	14045.06	0.203
8	response	0.049	14024.88	0.203
9	project	0.048	13671.72	0.197
10	development	0.044	12732.16	0.182

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	moe	0.746	0.528	2.183
2	subset	0.694	0.491	1.843
3	irapids	0.516	0.365	0.681
4	geography	0.387	0.274	-0.159
5	affairs	0.331	0.234	-0.529
6	mop	0.256	0.181	-1.017
7	maintainability	0.197	0.139	-1.404
8	usability	0.197	0.139	-1.404
9	data	0.143	0.101	-1.752
10	collection	0.079	0.056	-2.169

* Number of standard deviations from the mean of a random network of the same size and density

In Table 15 (period 5), we see the continued prominence of *data*, *collection*, and *network* as top nodes. The return of *sociocultural* and inclusion of *tcapf* and *assessment* highlight the continued framing of the new idea as a tool that could support data collection in the COIN environment. Recall from the case study that this period corresponds to the height of the Village Stability Operations (VSO) program in Afghanistan which required an understanding of the local social dynamics and tools such as SNA and TCAPF were being employed to try and gain this cultural understanding.

Table 15.   Core Network–Period 5

Time Period	5								
	Entire Network	**Core Network**							
Number of entities	1479	1182							
Average Degree	0.0001178	-							

Degree Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.007	958	2.485
2	collection	0.003	340	-0.573
3	irapids	0.002	210	-1.216
4	network	0.002	204	-1.246
5	tcapf	0.001	194	-1.295
6	assessment	0.001	190	-1.315
7	phase	0.001	158	-1.473
8	affairs	0.001	148	-1.523
9	application	0.001	144	-1.543
10	development	0.001	138	-1.572

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.3	327113.7	0.562
2	network	0.072	78922.43	0.134
3	irapids	0.062	67308.01	0.114
4	collection	0.058	63342.76	0.107
5	phase	0.045	48860.17	0.082
6	project	0.04	44168.44	0.074
7	visualization	0.039	42649.32	0.071
8	existing	0.029	32062.87	0.053
9	detailed	0.028	30333.04	0.05
10	development	0.028	30332.69	0.05

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.88	0.622	2.676
2	collection	0.714	0.505	1.363
3	collected	0.314	0.222	-1.807
4	sociocultural	0.203	0.144	-2.684
5	network	0.167	0.118	-2.974
6	handheld	0.135	0.096	-3.223
7	cases	0.118	0.084	-3.36
8	application	0.116	0.082	-3.375
9	capability	0.111	0.079	-3.415
10	build	0.109	0.077	-3.435

* Number of standard deviations from the mean of a random network of the same size and density

In Table 16 (period 6), *data* and *collection* remain the two nodes on all three measures of centrality. With the emergence of *fusion* and *portal*, we can see additional narratives of specific technology implementations of the idea as "Fusion Portal" was the name I conceived for the web-based platform to host and visualize the data collected by the mobile tool.

Table 16.   Core Network–Period 6

Time Period	6	
	Entire Network	**Core Network**
Number of entities	513	486
Average Degree	0.0009181	-

Degree Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.021	214	3.582
2	collection	0.014	142	1.72
3	fusion	0.006	64	-0.297
4	network	0.006	58	-0.452
5	assessment	0.005	54	-0.555
6	communications	0.005	50	-0.659
7	scd	0.005	48	-0.711
7	visualization	0.005	48	-0.711
8	reports	0.004	44	-0.814
9	real-time	0.004	36	-1.021
10	mission	0.003	34	-1.073
10	portal	0.003	34	-1.073

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.336	43968.53	4.207
2	collection	0.161	21030.73	1.968
3	assessment	0.111	14504.63	1.33
4	network	0.103	13449.23	1.227
5	phase	0.075	9807.797	0.872
6	development	0.074	9617.335	0.853
7	scd	0.069	8978.622	0.791
8	mission	0.046	5996.383	0.5
9	designed	0.042	5553.491	0.456
10	combined	0.042	5489.999	0.45

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.754	0.533	2.23
2	collection	0.619	0.437	1.393
3	fusion	0.387	0.273	-0.037
4	portal	0.261	0.184	-0.814
5	reports	0.22	0.156	-1.063
6	sensor	0.212	0.15	-1.112
7	visualization	0.199	0.14	-1.195
8	assessment	0.177	0.125	-1.328
9	communications	0.131	0.093	-1.613
10	report	0.121	0.086	-1.673

* Number of standard deviations from the mean of a random network of the same size and density

In Table 17 (period 7), we continue to see the prominence of *data*, *collection,* and *network* as top recurring nodes. In addition, *lighthouse, afghanistan, mohammad*, *communities*, and *operational* suggest this period aligns with the first operational employment of Lighthouse, the project name for the new idea, in Afghanistan. Of note, an actor of interest in the social network of one village was Hajji Mohammad Juma—an individual of whom we later based several analytic products and briefings.[24]

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[24] Hajji Mohammad Juma was a tribal leader in the Khakrez district of Afghanistan in mid-2010 when the first pilot test of the new idea was taken to the field. During the course of the 90-day data collection proof of concept, the prototype system allowed for socio-cultural data to be collected throughout the western part of Afghanistan. The unique position that Hajji Juma held within his social network was the topic of several briefings and articles (Longley, 2011) and provided an impactful story upon which several presentations and white papers were based.

Table 17.   Core Network–Period 7

Time Period	7	
	Entire Network	**Core Network**
Number of entities	1697	1382
Average Degree	0.00013	-

Degree Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.005	610	1.846
2	collection	0.004	404	0.474
3	network	0.002	266	-0.445
4	networks	0.001	138	-1.297
5	communities	0.001	134	-1.324
6	collect	0.001	122	-1.404
7	fusion	9.89E+00	114	-1.457
8	mohammad	9.54E+00	110	-1.484
9	developed	9.02E+00	104	-1.524
10	process	8.84E+00	102	-1.537

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.191	274726.5	0.289
2	collection	0.116	166186.7	0.174
3	afghanistan	0.069	99316.95	0.103
4	network	0.064	91359.09	0.095
5	operational	0.048	68928.57	0.071
6	portal	0.044	63219.82	0.065
7	application	0.039	56624.77	0.058
8	developed	0.035	50112.94	0.051
9	lighthouse	0.032	45370.44	0.046
10	connectivity	0.031	44405.54	0.045

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.839	0.593	2.124
2	collection	0.749	0.53	1.368
3	network	0.226	0.16	-3.043
4	collected	0.211	0.149	-3.172
5	reports	0.173	0.122	-3.491
6	collect	0.138	0.098	-3.788
7	management	0.122	0.086	-3.927
8	visualization	0.114	0.081	-3.99
9	metrics	0.112	0.079	-4.007
10	relational	0.11	0.078	-4.023

* Number of standard deviations from the mean of a random network of the same size and density

Table 18 (period 8) highlights the continued top rankings of *data*, *collection*, and *network* as the most central terms in the semantic network with additional terms such as *Afghanistan*, *network*, *communities*, and *members* appearing as important as well.

Table 18.   Core Network–Period 8

Time Period	8	
	Entire Network	**Core Network**
Number of entities	2000	1353
Average Degree	0.00007	-

Degree Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.004	904	1.782
2	network	0.002	406	-0.365
3	collection	0.002	370	-0.52
4	core	0.001	238	-1.089
5	figure	8.82E+00	194	-1.279
6	lab	8.73E+00	192	-1.287
7	management	6.46E+00	142	-1.503
8	afghanistan	6.28E+00	138	-1.52
9	networks	5.91E+00	130	-1.554
10	intelligence	5.82E+00	128	-1.563

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.17	338511	0.199
2	collection	0.098	196607.5	0.115
3	network	0.083	166547.6	0.098
4	members	0.049	97211.63	0.057
5	detachment	0.043	85972.46	0.05
6	communities	0.037	73170.35	0.043
7	developed	0.029	58745.71	0.034
8	figure	0.029	58160.31	0.034
9	identified	0.029	57517.46	0.033
10	afghanistan	0.028	55060.64	0.032

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.858	0.607	2.071
2	collection	0.733	0.518	0.962
3	network	0.282	0.199	-3.043
4	collected	0.215	0.152	-3.637
5	core	0.177	0.125	-3.974
6	lab	0.158	0.111	-4.144
7	management	0.157	0.111	-4.145
8	handheld	0.139	0.098	-4.311
9	export	0.118	0.084	-4.493
10	intelligence	0.109	0.077	-4.575

* Number of standard deviations from the mean of a random network of the same size and density

In Table 19 (period 9), we can identify a shift in the top nodes as *data*, *core*, *lighthouse*, *lab*, *odk*, and *methodology* have replaced *collection* and *network* has top terms. From the case, the emergence of "Lighthouse" as a top node should not be surprising as this name became the product "brand" of the new idea. Furthermore, the idea was framed as an innovative approach to collecting sociocultural data in the field *to support the CORE Lab methodology*. While the shift in core nodes suggests a shift in the central idea of the innovation, I argue that the shift is reflective of a refinement of the central idea behind the new idea. In the initial descriptions, the idea was described using concepts such as *data, collection, core, lab* and *methodology*. The emergence of *Lighthouse* reflects the branding applied to the same central idea and the *methodology* merely is representative of the convergence of many terms into a succinct description of the idea.

Table 19.   Core Network–Period 9

Time Period	9	
	Entire Network	Core Network
Number of entities	598	432
Average Degree	0.00042	-

Degree Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.005	182	-0.187
2	core	0.005	178	-0.224
3	lighthouse	0.004	134	-0.632
4	lab	0.003	120	-0.761
5	irregular	0.003	114	-0.817
6	methodologies	0.003	94	-1.002
7	collect	0.003	92	-1.021
8	strategies	0.003	90	-1.039
9	amount	0.002	78	-1.151
9	analytical	0.002	78	-1.151
10	collection	0.002	72	-1.206

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.276	49051.87	1.934
2	lighthouse	0.187	33268.06	1.299
3	odk	0.088	15634.53	0.588
4	program	0.077	13665.69	0.509
5	network	0.067	11865.26	0.436
6	collection	0.052	9320.168	0.334
7	lab	0.052	9221.475	0.33
8	sna	0.051	8984.672	0.32
9	requires	0.05	8965.745	0.319
10	visual	0.044	7906.205	0.277

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	core	0.831	0.588	2.751
2	lab	0.76	0.538	2.305
3	methodology	0.366	0.259	-0.163
4	program	0.285	0.202	-0.671
5	action	0.142	0.1	-1.571
6	components	0.11	0.078	-1.771
7	operational	0.108	0.076	-1.784
8	training	0.088	0.063	-1.903
9	comprised	0.088	0.062	-1.908
10	members	0.085	0.06	-1.926

* Number of standard deviations from the mean of a random network of the same size and density

In Table 20 (period 10), we can see a subtle reframing of Lighthouse away from the sociocultural data collection tool into one focused on *cmo* and *cim*. CMO references Civil Military Operations while CIM references Civil Information Management. During this period, the CORE Lab was looking for additional funding opportunities to maintain the project's development. The Civil Affairs (CA) community was approached as one potential source of funding and the new idea was framed in terms of a tool to support data collection for CA. In this section, we begin to see the emergence of narratives surrounding the application of the new idea. Whereas previous periods solidified the core ideas, Table 20 begins to demonstrate the emergence of narratives that were used to describe and provide context to the application of the idea to various audiences. In this case, the idea was framed as once to support civil military operations.

Table 20.   Core Network–Period 10

Time Period	10	
	Entire Network	**Core Network**
Number of entities	634	388
Average Degree	0.00096	-

Degree Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.018	184	4.871
2	conduct	0.008	86	1.345
3	lighthouse	0.008	78	1.057
4	cmo	0.008	76	0.985
5	collection	0.006	60	0.41
6	issac	0.006	58	0.338
7	collect	0.005	54	0.194
8	amount	0.005	52	0.122
8	branch	0.005	52	0.122
9	assess	0.005	50	0.05
9	training	0.005	50	0.05
10	capability	0.005	48	-0.022
10	cim	0.005	48	-0.022

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.282	56380.37	1.507
2	lighthouse	0.116	23236.27	0.603
3	cim	0.08	16047.11	0.407
4	cmo	0.054	10829	0.265
5	open_source	0.047	9417.167	0.226
6	application	0.043	8640.337	0.205
7	rdms	0.043	8639.684	0.205
8	commercial	0.042	8318	0.196
9	develop	0.041	8149.518	0.192
10	standards	0.038	7639.878	0.178

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.506	0.358	0.773
2	issac	0.37	0.262	-0.081
3	conduct	0.349	0.247	-0.212
4	assess	0.335	0.237	-0.304
5	training	0.276	0.195	-0.668
6	collection	0.272	0.193	-0.694
7	accuracy	0.205	0.145	-1.117
8	caos	0.204	0.144	-1.123
9	evaluation	0.19	0.135	-1.208
10	management	0.178	0.126	-1.283

* Number of standard deviations from the mean of a random network of the same size and density

In Table 21 (period 11), the top ranked nodes of *lighthouse*, *data*, *collection*, *core*, and *scd* suggest a return to the framing of the new idea as a tool to support sociocultural dynamics collection in support of the CORE Lab's methodologies. Interestingly, we see both *eod* and *ied* appear in the top 10 nodes for eigenvector centrality. These terms were associated with a spin-off from the new idea which framed the field data collection tool as a means of collecting improvised explosive device (IED) components for network analysis using social network analysis tools like ORA. Again, the central idea remained the same, but the narrative used to describe the idea shifted to an application supporting sociocultural dynamics and human terrain mapping.

Table 21.   Core Network–Period 11

Time Period	11	
	Entire Network	**Core Network**
Number of entities	642	351
Average Degree	0.0007804	-

Degree Centrality

Rank	Concept	Value	Unscaled	Context*
1	lighthouse	0.015	158	4.769
2	data	0.009	90	2.042
3	core	0.005	54	0.598
4	collection	0.004	44	0.197
5	analytic	0.004	42	0.117
5	lab	0.004	42	0.117
6	irregular	0.004	40	0.037
7	geospatial	0.004	38	-0.043
8	training	0.004	36	-0.123
9	amount	0.003	32	-0.284
10	project	0.003	30	-0.364

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	lighthouse	0.233	47750.16	1.03
2	data	0.105	21460.97	0.449
3	scd	0.09	18487.04	0.383
4	network	0.083	16956.8	0.349
5	collection	0.064	13054.93	0.263
6	training	0.048	9908.926	0.193
7	analytic	0.038	7797.962	0.146
8	irregular	0.034	6948.366	0.128
9	core	0.033	6673.919	0.122
10	phones	0.031	6357	0.115

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	lighthouse	0.715	0.505	2.15
2	collection	0.363	0.256	-0.024
3	data	0.345	0.244	-0.135
4	project	0.315	0.223	-0.32
5	called	0.205	0.145	-0.996
6	eod	0.169	0.119	-1.221
7	ied	0.169	0.119	-1.221
8	management	0.151	0.107	-1.329
9	geospatial	0.148	0.105	-1.35
10	rms	0.136	0.096	-1.425

* Number of standard deviations from the mean of a random network of the same size and density

In Table 22 (period 12), we see the emergence of *MARCIMS* in the degree centrality table. Recall from the case study that MARCIMS became one of the implementations of the new idea that transitioned into an official program of record. While the CORE Lab was supporting the ONR and the MEC with the transition efforts, the lab continued to try and communicate the new idea called *lighthouse* as a capability to support the CORE methodology. This narrative, which first appeared in Table 18, emerged again as the collaboration with the MEC continued to reinforce the application to support civil military operations applications.

Table 22.   Core Network–Period 12

Time Period	12	
	Entire Network	**Core Network**
Number of entities	523	475
Average Degree	0.0005969	-

Degree Centrality

Rank	Concept	Value	Unscaled	Context*
1	lighthouse	0.01	158	1.103
2	knowledge	0.007	116	0.327
3	core	0.007	106	0.142
4	data	0.006	98	-0.006
5	lab	5.00E-03	84	-0.265
6	marcim	4.00E-03	58	-0.745
7	methodology	4.00E-03	56	-0.782
8	training	3.00E-03	54	-0.819
9	automatically	3.00E-03	52	-0.856
10	semantic	3.00E-03	46	-0.967
10	vso	0.003	46	-0.967

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	lighthouse	0.267	36303.54	2.341
2	knowledge	0.109	14849.45	0.921
3	data	0.084	11429.81	0.695
4	vso	0.063	8536.004	0.503
5	form	0.056	7582.57	0.44
6	automatically	0.05	6840.511	0.391
7	structured	0.048	6514.745	0.369
8	collection	0.038	5116.912	0.277
9	assessment	0.033	4446.391	0.233
10	marcim	0.032	4381.729	0.228

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	core	0.684	0.483	1.855
2	lab	0.613	0.433	1.422
3	methodology	0.446	0.315	0.4
4	lighthouse	0.42	0.297	0.243
5	training	0.171	0.121	-1.28
6	capability	0.155	0.11	-1.375
7	methods	0.092	0.065	-1.761
8	app	0.089	0.063	-1.778
9	vso	0.088	0.062	-1.788
10	seminar	0.08	0.056	-1.837

* Number of standard deviations from the mean of a random network of the same size and density

In Tables 23, 24, and 25 (periods 13 through 15), the top ranked nodes continue to include *data*, *lighthouse*, *collection*, and *network* providing evidence to support the idea that the core concepts that were used to communicate the new idea remained stable from the first period until now.

Table 23.   Core Network–Period 13

Time Period	13	
	Entire Network	**Core Network**
Number of entities	879	635
Average Density	0.00027	-

Degree Centrality

Rank	Concept	Value	Unscaled	Context*
1	lighthouse	0.008	330	1.641
2	data	0.007	300	1.311
3	collection	0.004	170	-0.118
4	network	0.004	144	-0.404
5	advanced	3.00E-03	114	-0.734
6	core	3.00E-03	110	-0.778
7	project	3.00E-03	106	-0.822
8	methodologies	2.00E-03	98	-0.91
9	analytic	2.00E-03	70	-1.218
9	lab	2.00E-03	70	-1.218
10	haji	0.002	66	-1.262
10	mohammad	0.002	66	-1.262

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	lighthouse	0.218	84003.66	0.806
2	data	0.143	54891.92	0.522
3	network	0.107	41079.3	0.388
4	collection	0.069	26530.25	0.246
5	project	0.06	23082.91	0.212
6	affairs	0.053	20516.01	0.187
7	core	0.052	19976.43	0.182
8	designed	0.041	15615.42	0.139
9	analytic	0.04	15501.16	0.138
10	influence	0.039	15128.01	0.134

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.706	0.499	1.835
2	collection	0.65	0.46	1.458
3	lighthouse	0.539	0.381	0.709
4	project	0.288	0.204	-0.975
5	methodologies	0.232	0.164	-1.355
6	advanced	0.212	0.15	-1.486
7	structured	0.175	0.124	-1.736
8	network	0.161	0.114	-1.833
9	core	0.158	0.111	-1.855
10	process	0.149	0.106	-1.911

* Number of standard deviations from the mean of a random network of the same size and density

Table 24.   Core Network–Period 14

Time Period	14	
	Entire Network	**Core Network**
Number of entities	487	453
Average Degree	0.002	-

Degree Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.025	122	4.381
2	lighthouse	0.024	116	4.07
3	lh	0.017	82	2.306
4	collection	0.012	58	1.061
5	project	1.00E-02	50	0.646
6	application	9.00E-03	46	0.439
7	ied	9.00E-03	42	0.232
7	spiral	9.00E-03	42	0.232
8	deliverables	8.00E-03	40	0.128
8	iedna	8.00E-03	40	0.128
8	moe	0.008	40	0.128
9	afpak	0.007	36	-0.08
9	methodology	0.007	36	-0.08
10	months	0.007	32	-0.287
10	sna	0.007	32	-0.287

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	lighthouse	0.165	19424.68	2.404
2	data	0.127	14965.96	1.827
3	lh	0.117	13746.56	1.67
4	programs	0.083	9764.006	1.155
5	project	0.055	6462.112	0.728
6	collection	0.051	6011.069	0.669
7	application	0.045	5335.307	0.582
8	gang	0.044	5170.71	0.561
9	goals	0.042	4933.732	0.53
10	developed	0.041	4870.661	0.522

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.552	0.391	0.98
2	lighthouse	0.475	0.336	0.506
3	ied	0.295	0.209	-0.59
4	collection	0.288	0.204	-0.631
5	lh	0.288	0.203	-0.635
6	project	0.282	0.199	-0.672
7	application	0.244	0.172	-0.904
8	iedna	0.199	0.141	-1.176
9	deliverables	0.183	0.129	-1.277
10	requested	0.156	0.11	-1.441

* Number of standard deviations from the mean of a random network of the same size and density

Table 25.   Core Network–Period 15

Time Period	15	
	Entire Network	**Core Network**
Number of entities	223	218
Average Degree	0.004	-

Degree Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.045	100	3.213
2	lighthouse	0.032	70	1.658
3	required	0.020	44	0.31
4	expeditionary	0.014	32	-0.312
4	networks	0.014	32	-0.312
5	collection	0.012	26	-0.623
5	non-classified	0.012	26	-0.623
6	advanced	0.011	24	-0.727
6	cross-domain	0.011	24	-0.727
7	effectively	0.010	22	-0.831
7	ingestion	0.010	22	-0.831
7	network	0.010	22	-0.831
8	enables	0.009	20	-0.935
8	structured	0.009	20	-0.935
9	commands	0.008	18	-1.038
9	commercial	0.008	18	-1.038
9	knowledge	0.008	18	-1.038
10	capability	0.007	16	-1.142
10	component	0.007	16	-1.142
10	methodology	0.007	16	-1.142
10	requires	0.007	16	-1.142
10	sharing	0.007	16	-1.142
10	supported	0.007	16	-1.142

Betweenness Centrality

Rank	Concept	Value	Unscaled	Context*
1	required	0.25	6129.834	10.898
2	lighthouse	0.204	5011.547	8.798
3	data	0.165	4045.503	6.985
4	networks	0.116	2846.139	4.733
5	siprnet	0.101	2466.925	4.021
6	existing	0.099	2425.702	3.943
7	cross-domain	0.091	2222.262	3.561
8	non-classified	0.086	2117.864	3.365
9	component	0.077	1892.024	2.941
10	collection	0.066	1613.601	2.419

Eigenvector Centrality

Rank	Concept	Value	Unscaled	Context*
1	data	0.75	0.53	-2.803
2	lighthouse	0.529	0.374	-4.056
3	collection	0.294	0.208	-5.387
4	structured	0.256	0.181	-5.606
5	ingestion	0.244	0.172	-5.674
6	non-classified	0.241	0.171	-5.687
7	fusion	0.23	0.163	-5.752
8	collected	0.193	0.137	-5.96
9	deployment	0.158	0.112	-6.158
10	enables	0.153	0.108	-6.187

* Number of standard deviations from the mean of a random network of the same size and density

a.   Summary

In sum, the core network analysis offers evidence in support of the two propositions—the central concept behind the idea remained constant while the description and application of the idea was modified to garner support with various communities and stakeholders. To reinforce these propositions, I took the top five terms associated with each of the core network measures per time period—degree centrality, betweenness centrality, and eigenvector centrality—and aggregated these into a single count. These counts were then graphed to highlight the most frequently occurring terms in the "top five" scores across the core network measures.
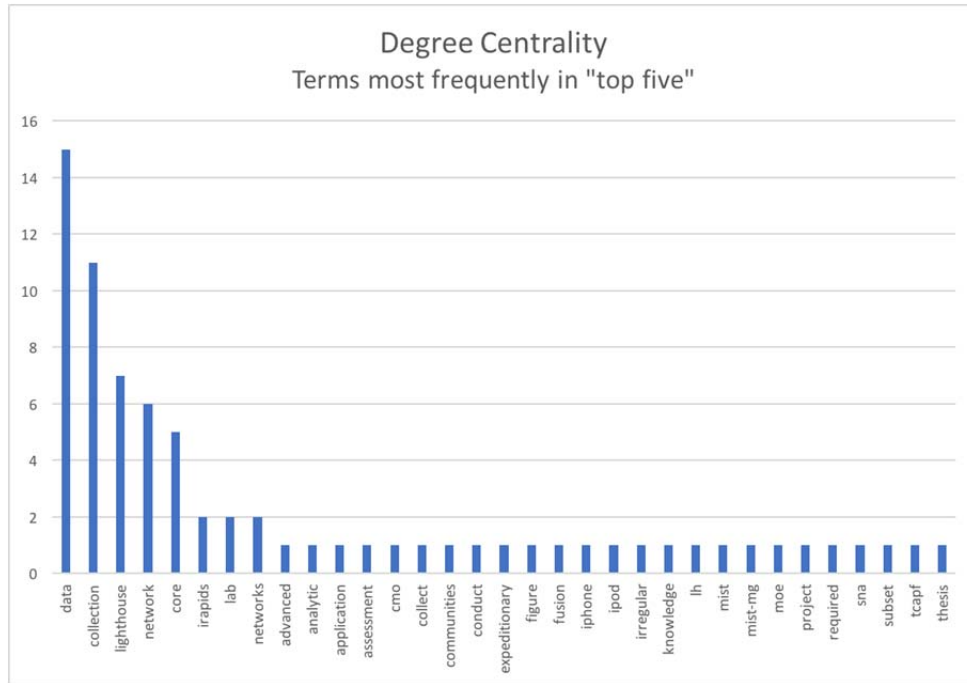
Figure 16.   Terms Most Frequently Appearing in Top-Five Scores
for Degree Centrality

In Figure 16, we see that the terms that appeared most often in the top five scores for degree centrality include *data*, *collection*, *lighthouse*, *network*, *core*, *irapids*, *lab*, and *networks*. Each of these terms were associated with the description of the central idea over time, while terms that appeared less often were used to describe aspects of the central idea or were used to craft narratives about the central idea (e.g., *tcapf, irregular, expeditionary*).
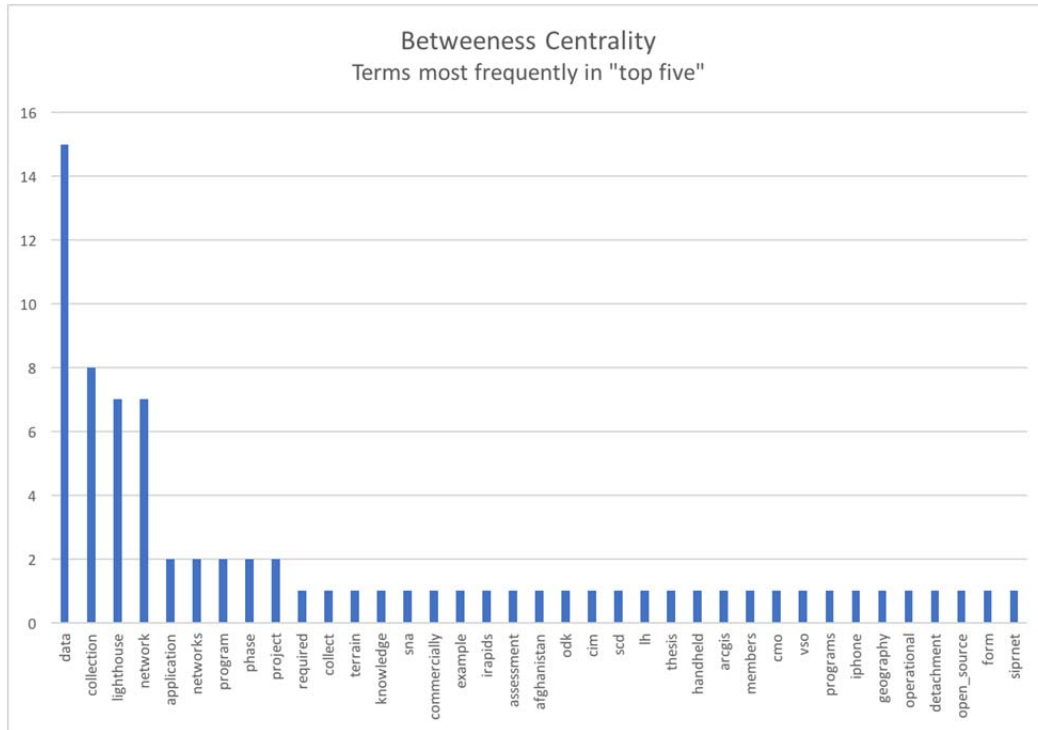
Figure 17.   Terms Most Frequently Appearing in Top-Five Scores for
Betweenness Centrality

Figure 17 highlights the terms that appeared most often in the top five scores for betweenness centrality. The most frequently appearing terms include *data*, *collection*, *lighthouse*, and *network* which all contribute to supporting the central idea proposition, whereas terms that scored within the top five, but appeared less often include terms that were often associated with the different uses/narratives of the idea (e.g., *Afghanistan*, *cmo*, *vso*, *geography*, *iphone*).
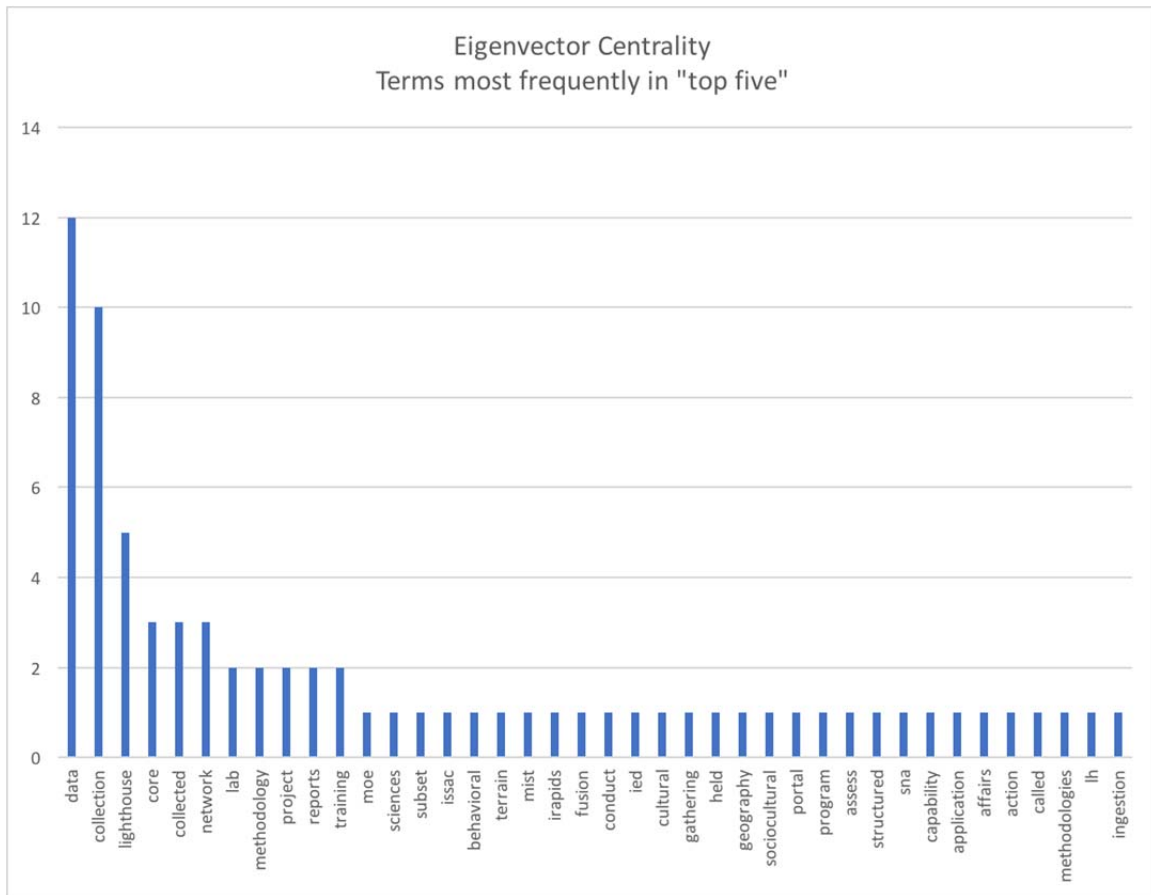
Figure 18.   Terms Most Frequently Appearing in Top-Five Scores for
Eigenvector Centrality

Finally, Figure 18 highlights the terms that appear most frequently in the top five for eigenvector centrality. The continuing dominance of terms like *data*, *collection*, *lighthouse* continue to reinforce the core idea proposition while the emergence of terms such as *core*, *network*, *lab, methodology*, *project*, *reports*, and *training* are terms most often associated with the development of the idea and entrepreneurial team supporting the idea.

3.   Communicative Power Analysis

Let us now turn to a communicative power analysis of the network over time. The intent behind this section is to support both propositions of the core idea and the various frames used to describe the idea for different applications.

In a communicative power analysis, concepts are generated from a composite score based on whether they have high or low values for the following measures: total degree centrality, betweenness centrality, and consensus (Carley & Kaufer, 1993).[25] The combined score is the average of the three values. A high value is one standard deviation above the mean value for concepts, and a low value is one standard deviation below the mean value (Carley & Kaufer, 1993). Using Carley and Kaufer's semantic typology (1993), the communicative power analysis identifies semantic concepts (i.e., ordinary, factoids, buzzwords, allusions, stereotypes, placeholders, and symbols) for each period. While each of these is defined in the subsequent sections, Table 26 highlights the presence of these typologies and expresses them both as a quantity and a percentage of the total. While I will discuss each of the semantic typologies in the following sections, the symbol category is by far the largest category of all the typologies and one that offers the most insights.

Table 26.   Communicative Power Analysis

Communicative Power Analysis																
	1		2		3		4		5		6		7		8	
	#	%	#	%	#	%	#	%	#	%	#	%	#	%	#	%
Ordinary Word	1	1.20%	1	0.32%	2	0.27%	3	0.42%	27	1.92%	6	1,23%	19	1.15%	2	0.11%
Factoid	1	1.20%	3	0.97%	2	0.27%	2	0.28%	3	0.21%	2	0.41%	4	0.24%	2	0.11%
Buzzword	0	0.00%	0	0.00%	16	2.14%	8	1.12%	26	1.85%	10	2.06%	31	1.88%	6	0.33%
Emblem	0	0.00%	0	0.00%	0	0.00%	0	0.00%	5	0.36%	0	0.00%	4	0.24%	0	0.00%
Allusion	0	0.00%	1	0.32%	1	0.13%	1	0.14%	0	0.00%	3	0.62%	0	0.00%	0	0.00%
Stereotype	4	4.82%	4	1.29%	3	0.40%	1	0.14%	12	0.85%	1	0.21%	19	1.15%	3	0.16%
Placeholder	0	0.00%	3	0.97%	7	0.94%	7	0.98%	0	0.00%	7	1.44%	0	0.00%	0	0.00%
Symbol	14	16.87%	48	15.53%	105	14.06%	112	15.73%	261	18.55%	52	10.70%	305	18.53%	348	19.05%
	9		10		11		12		13		14		15			
	#	%	#	%	#	%	#	%	#	%	#	%	#	%		
Ordinary Word	3	0.54%	2	0.34%	2	0.37%	2	0.42%	2	0.24%	2	0.44%	2	0.92%		
Factoid	1	0.18%	2	0.34%	2	0.37%	2	0.42%	1	0.12%	1	0.22%	1	0.46%		
Buzzword	24	4.35%	12	2.07%	25	4.62%	7	1.47%	10	1.22%	5	1.10%	3	1.38%		
Emblem	1	0.18%	0	0.00%	2	0.37%	3	0.63%	2	0.24%	0	0.00%	0	0.00%		
Allusion	0	0.00%	0	0.00%	1	0.18%	1	0.21%	0	0.00%	0	0.00%	0	0.00%		
Stereotype	3	54.00%	1	0.17%	0	0.00%	5	1.05%	0	0.00%	2	0.44%	1	0.46%		
Placeholder	0	0.00%	2	0.34%	7	1.29%	9	1.89%	5	0.61%	6	1.32%	4	1.83%		
Symbol	78	14.13%	74	12.76%	65	12.01%	94	19.79%	139	16.99%	66	14.57%	34	15.60%		

[25] Recall that consensus is defined as "the number of direct links that meet or exceed some threshold" (Carley & Kaufer, 1993, p. 189). It is best understood as a word that appears across several semantic text networks.

Ordinary concepts are those defined as having low degree, low betweenness, and low consensus. If a term is low in degree centrality, there are relatively few other nodes connected to it. If a term is low in betweenness centrality, it does not sit on any critical path between key nodes (in other words–it is not a modifier or descriptor of other nodes). Table 27 displays the concepts identified as ordinary words by period. Of the terms that do appear, few provide any insights into how the new idea was described or communicated over time. Because I was interested in key concepts and how those concepts evolved over time, concepts being identified as "ordinary" were of little relevance to this analysis. I have chosen to keep this concept class in the document, however, for completeness sake.

Table 27.   Ordinary Concept Class by Period

Ordinary (low degree, low betweenness, low consensus)							
Time Period							
Rank	1	2	3	4	5	6	7	8
1	15mar-19mar	1980s	advancing	involve	addresses	optimizing	robin	1-mode
2	-	-	according_to	accomplished	engaging	enabling	logical	1-Sep-11
3	-	-	-	acting	modular	ha	performer	-
4	-	-	-	-	minimize	decisions-from	simplified	-
5	-	-	-	-	interoperation	3d	identified	-
6	-	-	-	-	draft	advancement	approved	-
7	-	-	-	-	knowledge	-	taxi	-
8	-	-	-	-	for_real	-	extensible	-
9	-	-	-	-	local-storage-and-upload	-	fee	-
10	-	-	-	-	inserts	-	staffing	-
Time Period							
Rank	9	10	11	12	13	14	15	
1	9th	0x7fbbfd59aff0	descriptions	affairs	7s	accomplish	ability	
2	apple	account2	10mb	30th	adaptation	actor	adaptable	
3	21st	-	-	-	-	-	-	
4	-	-	-	-	-	-	-	
5	-	-	-	-	-	-	-	
6	-	-	-	-	-	-	-	
7	-	-	-	-	-	-	-	
8	-	-	-	-	-	-	-	
9	-	-	-	-	-	-	-	
10	-	-	-	-	-	-	-	

b.   *Factoids*

Factoids are concepts that are defined as having low degree, low betweenness, and high consensus. Factoids are nodes with relatively few links (either in terms of count

or on the shortest path within the network) but are common across semantic networks (high consensus). As can be seen in Table 28, the inclusion of factoids such as *proposal*, *projects*, *cases*, and *milestone* hint at the connection of these terms to documents related to obtaining funding for the new idea. Proposals, projects, cases, and milestones are terms that would appear in either the solicitation of research funds or in the execution of funds on a funded project. Given the sparse nature of this table, however, the interpretation I have provided requires a background understanding of the activities taking place during these time windows—it is not clear from these data alone.

Table 28.　　Factoids Concept Class by Period

Factoids(low degree, low betweenness, high consensus)							
Time Period							
Rank	1	2	3	4	5	6	7	8
1	proposal	projects	app	individual	computer	irb	academic	children
2	-	mcioc	additionally	cases	refine	unknown_individual	scope	kind_of
3	-	as_long_as	-	-	thoroughfare	-	decisions	-
4	-	-	-	-	-	-	detrimental	-
5	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-
Time Period							
Rank	9	10	11	12	13	14	15	
1	benefit	lab	milestone	ball	milestone	source	lab	
2	-	dministration	month	capes	-	-	-	
3	-	-	-	-	-	-	-	
4	-	-	-	-	-	-	-	
5	-	-	-	-	-	-	-	
6	-	-	-	-	-	-	-	
7	-	-	-	-	-	-	-	
8	-	-	-	-	-	-	-	
9	-	-	-	-	-	-	-	
10	-	-	-	-	-	-	-	

c.　　*Buzzwords*

Buzzwords are concepts that are defined as having low degree, high betweenness, and low consensus). Table 29 below highlights the identified buzzwords in the corpus. Interestingly, there are few repeated terms across all time periods. If each time period is

taken in isolation and the reader looks at each column of data, the terms used to describe the new idea at each point in time begin to coalesce. Period three includes terms such as *tigr*, *brigade*, *connecting*, and *hsdpa*—all terms related to field data collection for military operations. Period four shifts to describing the idea to complement *biometric* systems and references an exercise in the Pacific called *balikatan*. Across the remaining columns one can see the idea framed in terms of *academia*, military *conop*(s), *counter-terrorism*, *experimentation*, and *methodologies* to name a few. The emergence of each of these terms supports the proposition that the idea was described slightly differently based on the audience.

Table 29.   Buzzwords Concept Class by Period

Buzzwords(low degree, high betweenness, low consensus)							
Time Period							
Rank	1	2	3	4	5	6	7	8
1	-	-	sites	bow	strictly	shape	failed	counter-terrorism
2	-	-	outset	biometric	unusual	concepts	conop	escalation
3	-	-	layer	definitions	academia	operation	event	form-based
4	-	-	tigr	predictive	beds	improvements	consolidation	act_as
5	-	-	speed	acts	seemingly	globe	kaf	interfere
6	-	-	brigade	balikatan	q2	isvg	convenient	characterizing
7	-	-	witnessed	portion	mortenson	sfa	helps	-
8	-	-	involve	proactively	associative	picture	complement	-
9	-	-	connecting	-	tag	strategies	intensive	-
10	-	-	hsdpa	-	respondent	todays	adopting	-
Time Period							
Rank	9	10	11	12	13	14	15	
1	structuring	standards	techniques	smartphones	network-centric	proposed	methodologies	
2	experimentation	portal	aims	countrys	focus_on	reverted	economic	
3	database	z10csp1548345ier	enhance	collaborate	evident	local	ongoing	
4	execution	quick-look	discover	social-cultural	adm	computer	-	
5	sector	overlooked	improve	allied	deliverables	tracnet	-	
6	accessed	breadth	rip	as_one	exploit	-	-	
7	technological	dealing	eddie	migrate	removal	-	-	
8	acquisition	enhanced	purchases	-	fy	-	-	
9	discussed	aggregates	biggest	-	recalculation	-	-	
10	low-cost	migrate	sherrie	-	accessible	-	-	

d.   Emblems

Emblems are concepts that are defined as having low degree, high betweenness, and high consensus. Of the 15 periods, only six have any concepts that match an emblem (Table 30). Few insights can be gleaned from this table as there is insufficient data to interpret.

Table 30. Emblems Concept Class by Period

	Emblems(low degree, high betweenness, high consensus)														
	Time Period														
Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	-	-	-	-	envisioned	-	computer	-	demonstration	-	fielded	united_states	spectrum	-	-
2	-	-	-	-	indigenous	-	cultural	-	-	-	systems	cced	nature	-	-
3	-	-	-	-	purpose	-	strategic	-	-	-	-	stored	-	-	-
4	-	-	-	-	upgrades	-	hardware	-	-	-	-	-	-	-	-
5	-	-	-	-	national	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

e. Allusions

Allusions are concepts that are defined as having high degree, low betweenness, and low consensus. In a similar nature to the previous section (emblems), the limited number of allusions throughout the entire period provides little data to make generalized interpretations from this list (Table 31).

Table 31. Allusions Concept Class by Period

	Allusions(high degree, low betweenness, low consensus)														
	Time Period														
Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	-	distributed	pxml	merit	-	relationships	-	-	-	-	untrainable	automates	-	-	-
2	-	-	-	-	-	requirements	-	-	-	-	-	-	-	-	-
3	-	-	-	-	-	macro	-	-	-	-	-	-	-	-	-
4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

f. Stereotypes

Stereotypes are concepts that are defined as having high degree, low betweenness, and high consensus. The stereotypes are listed in Table 32. Based on how stereotypes are calculated, we expect to see terms that have a high number of ties (degree) and a high

number of links above a threshold (consensus), but are not necessarily on the shortest path between nodes. For this corpus, the stereotypes generated appear to closely match the context and framing of the new idea over time. We see the *CORE Lab* in period one which aligns with the project origination. The early emphasis on socio-cultural dynamics (*scd*) and *civilaffairs* provided an initial basis for describing the motivation for improving field data collection. As the idea progressed through time, the importance of social network analysis and data structuring for tools like *pajek* became more prominent. *Ethnographic* intelligence focused on *connections* such as *kinship* ties firmly anchored the communication of the new idea in the context of a tool to support village stability operations. An *analyst* could develop *district products* both *pre-mission* and on the *battlefield*. While the stereotypes trail off in the latter time periods, several of the concepts identified were previously described in the case as being relevant to the framing of the new idea.

Table 32.   Stereotypes Concept Class by Period

Stereotypes (high degree, low betweenness, high consensus)							
Time Period							
Rank	1	2	3	4	5	6	7	8
1	core	scd	report	pajek	connections	fusionview	supported	referred
2	lab	experts	example	-	referred	-	dtic	focusing
3	metrics	corps	civilaffairs	-	automating	-	effects	district-products
4	process	strategic	-	-	enhanced	-	forecasting	-
5	-	-	-	-	kinship	-	gained	-
6	-	-	-	-	milspec	-	sotf-s	-
7	-	-	-	-	communication	-	stability	-
8	-	-	-	-	complete	-	compatible	-
9	-	-	-	-	ethnographic	-	sheik	-
10	-	-	-	-	interagency	-	engage	-
Time Period							
Rank	9	10	11	12	13	14	15	
1	focusing	deliverables	-	pre-mission	-	times	infrastructure	
2	analyst	-	-	proof	-	requested	-	
3	goal	-	-	blue	-	-	-	
4	-	-	-	background	-	-	-	
5	-	-	-	battlefield	-	-	-	
6	-	-	-	-	-	-	-	
7	-	-	-	-	-	-	-	
8	-	-	-	-	-	-	-	
9	-	-	-	-	-	-	-	
10	-	-	-	-	-	-	-	

g. *Placeholders*

Placeholders are concepts that are defined as having high degree, high betweenness, and low consensus. Table 33 highlights the placeholders identified in the communicative power analysis. As these scores are moderated by having a low consensus, the terms that appear across the periods have a high degree of links, both in terms of count and on the shortest path between nodes. In practice, this composite score translates to identifying terms that were frequently used in relation to describing the new idea, but did not necessarily describe the new idea itself. As an example, the appearance of *pajek*, *shp*, *net*, *xml*, and *earth* in period three reference common file formats for geospatial, link, and social network analysis. These terms were drawn from the briefs which described the data portability and interoperability of the field data collection app.

Table 33.   Placeholders Concept Class by Period

Placeholders(high degree, high betweenness, low consensus)															
Time Period															
Rank	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15
1	-	ltsn	pajek	defiance	-	broad	-	-	-	loi	rct-1	harnessing	cambodia	enhanced	tsocs
2	-	simulataneously	shp	respect	-	images	-	-	-	criteria	sigacts	continue	bypass	photo	hoa
3	-	preserving	earth	rank	-	positively	-	-	-	-	ltg	essential	singapore	quantitative	attacking
4	-	-	socio	submit	-	asset	-	-	-	-	caos	share	dashboard	instance	secure
5	-	-	net	tested	-	bubbles	-	-	-	-	labs	rely_on	in_reserve	tboc	-
6	-	-	of_course	specification	-	icons	-	-	-	-	insurgency	inflexible	-	iedna	-
7	-	-	xml	counter-threat	-	log	-	-	-	-	expended	government	-	-	-
8	-	-	-	-	-	-	-	-	-	-	-	plots	-	-	-
9	-	-	-	-	-	-	-	-	-	-	-	required	-	-	-
10	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

h. *Symbols*

Symbols are concepts that are defined as having high degree, high betweenness, and high consensus. Table 34 highlights the symbols over time for the new idea. In comparison to the core network measures in the previous section, the symbols in each period closely mirror the words identified as scoring high on degree, betweenness, and eigenvector centrality. In the symbol table below, *data*, *collection,* and *network* continue to rank the highest among the symbols suggesting that the core of the new idea remained constant across all time periods. What does change, and as is seen in Table 32, are the additional terms, project names, and reference points such as *intel*, *scd*, *terrain*, *cim*, *vso*,

gang, and *methodology*. These symbols closely mirror the reframing of the new idea in terms that would resonate with specific audiences.

Table 34.   Symbols Concept Class by Period

Symbols(high degree, high betweenness, high consensus)							
	Time Period						
Rank	1	2	3	4	5	6	7	8
1	thesis	data	data	data	data	data	data	data
2	data	network	collection	application	network	collection	collection	collection
3	iw	commercially	application	collection	collection	assessment	network	network
4	sna	collection	terrain	example	irapids	network	afghanistan	members
5	collect	project	iphone	geography	phase	phase	operational	detachment
6	intel	devices	arcgis	thai	project	scd	portal	communities
7	program	iphone	mist	relationship	visualization	development	application	figure
8	cultural	handheld	developing	project	application	mission	developed	developed
9	terrain	htacs	project	concept	development	designed	lighthouse	afghanistan
10	behavioral	thesis	program	development	existing	combined	connectivity	identified

	Time Period						
Rank	9	10	11	12	13	14	15
1	data	data	lighthouse	lighthouse	lighthouse	lighthouse	required
2	lighthouse	lighthouse	data	knowledge	data	data	lighthouse
3	odk	cim	scd	data	network	lh	data
4	program	cmo	network	vso	collection	programs	networks
5	network	conduct	collection	form	project	collection	existing
6	lab	rdms	training	automatically	core	project	cross-domain
7	collection	open_source	analytic	structured	affairs	application	non-classified
8	core	collect	core	core	analytic	gang	collection
9	visual	application	irregular	marcim	advanced	methodology	component
10	irregular	develop	phones	collection	designed	goals	effectively

i.   *Summary*

The communicative power analysis provided varying degrees of insight into the entrepreneur's communications about the new idea—in terms of context, framing, or technical merit. The emphasis on specific terms does not provide an easily discernible "narrative" that can stand in isolation, and unfortunately, the results of this analysis still require a significant amount of interpretation and reference to knowledge of how the entrepreneur managed the meaning about the new idea over time. Nevertheless, the analysis presented thus far does support both propositions of the stability of the core idea and the changes to the narrative to increase attractiveness to different audiences. To ensure that I am not merely interpreting the results to support my propositions, community detection was applied to the corpus to determine if any discernible structure

could be identified from the semantic network to augment the network visualizations, core network metrics, and the communicative power analysis.

4.   Community Detection

The last step in the semantic network analysis is to identify any groups of nodes that can be clustered together using community detection algorithms. Community detection has emerged as a process for extracting structure from networks (Cunningham, Everton, & Murphy, 2016). While the communicative power analysis focused on identifying key nodes across time, community detection algorithms, by identifying clusters of concepts, should help unveil the structure that emerges from related concepts over time within the corpus. In other words, they should both identify the core description of the central idea as well as identify any of the prominent narratives used to describe the application of the idea for key audiences.

For this analysis, I have chosen to use the Clauset, Newman, and Moore (2004) algorithm to detect groups within each period of the corpus. The algorithm is well suited for large networks (many of the networks for the semantic analysis have several thousand vertices and several thousand more edges). As I made no *a priori* assumptions about group size or the number of groups to detect for each period, I allowed ORA to generate as many groups as were possible within each period. Due to the size of the tables generated, I have restricted the visualizations to only the top 10 groups per period—the equivalent number of topics generated during topic modeling later in the chapter.

In Table 35, the top three Newman groups read like three separate conversations about the new idea:

- Group 1- the new idea was a *handheld collection project* to gather *data* for *sna* (support for the proposition that the core idea remained constant)

- Group 2- *cultural behavioral modeling* for *intel* and *io* (support for the proposition that the idea was framed to support different audiences)

- Group 3- socio-cultural thesis concept

Table 35.   Newman Groups–Period 1

Time period	1	
Newman Modularity Score	0.806	

Group	Size	Members
1	16	bytes, collected, collection, data, develop, disrupting, excel, export, formats, handheld, metrics, networks, project, sna, terrain, zip
2	9	behavioral, cultural, extensive, intel, io, mccdc, mcwl, modeling, sciences
3	9	concept, generate, geographic, htacs, iw, legs, program, socio-cultural, thesis
4	6	analyze, collect, dissimenate, exercises, process, technical
5	5	applications, corp, corps, marine, prototyping
6	4	culture, exist, for_example, ghostnet
7	4	marcorsyscom, marcosyscom, marsof, requirement
8	3	complex, relationships, understanding
9	3	informal, methods, observation
10	2	15mar-19mar, troops

This pattern continues in Table 36, with groups 1–5 describing characteristics or features of the new idea whereas group 6 describes a context in which the idea can be applied—*coin, counterinsurgency, stability, international, ops*.

Table 36.   Newman Groups–Period 2

Time period	2	
Newman Modularity Score	0.759	

Group	Size	Members
1	43	aggregation, attributes, build, capability, collected, collection, communication, conceived, countries, data, developing, dissemination, enhanced, ethnographic, exists, focusing,
2	42	1980s, american, analyzing, bottom, called, cells, central, characteristics, comms, communications, components, conduct, corps, distributed, dkkn, enable, enhance, exercise, existing, format, geospatial, hardware, knowledge, large, larger, late, latin, links, ltsn, marine, mcioc, network, oversight, sensor, sfo, shortfalls, thailand, topology, units, usage, utilize,
3	30	accessed, analysts, brings, concept, conjunction, core, demonstration, devices, evaluation, harvested, htacs, hybrid, integrity, lab, lightweight, location-aware, multiple, physical, preserving, professors, program, recognized, researchers, serve, simultaneously, transmitted,
4	30	allows, application, applications, commercially, customers, customizable, darpa, develop, development, fully, functioning, gathered, generation, in_line_with, integrating, iphone, iphones, ipod, leverage, multitude, projects, proposal, reduces, reporting, tigr, touch, touches, unique,
5	23	aims, briefing, cultural, deliverable, dynamics, economic, elements, export, extremely, focuses, internationally, intrigued, involving, led, networking, objective, onr, posited, project, scd,
6	18	coin, constructive, counterinsurgency, extractive, fdi, focus_on, growing, international, mnc, mncs, multinationals, ops, private, role, sector, stability, studies, telecom
7	14	bridge, campbell, deficiencies, developed, ensemble, experts, fielded, ft, land, soldier, tailored, technical, warrior, well-rounded
8	7	accurately, customized, generate, relational, reports, represent, used_to
9	7	as_long_as, comfortable, demoing, feel, io, modules, targeting
10	6	candidate, fletcher, paper, presentation, rand, yesterday

In Table 37, the partitioning of words into groups reflects how the new idea was being framed for audiences:

- Group 2–the words that appear in this group frame the idea in terms of a human terrain mapping capability that can be used for sociocultural data collection (note: I briefed my ideas to the Office of Naval Research (ONR)

on several occasions and the human geography language is present in this group related to those discussions)

- Group 4–the 95th Civil Affairs Brigade was approached as the new idea was framed a replacement to the *gater handheld*

- Group 10–highlights several terms that were attached to frame the idea as a tool to support *counterinsurgency*, *counternarcotics*, *humanitarian* operations etc.

Table 37.   Newman Groups–Period 3

Time period	3	
Newman Modularity Score	0.736	

Group	Size	Members
1	93	ability, aggregation, aiming, allows, amount, analytical, appealing, archived, articles, automating, bearing, behaviors, build, call_out, capability, coin, collect, collected, collecting, collection, come_in, communication, complete, conducted, counterinsurgency, customers, data, database, depict, docks, ecologists, end-to-end, enhance, enter, epidemiological, epidemiologists, example, focuses, frameworks, front-end, geo-referenced, geoda, geodacenter, geospatial, greater, hardware, in_order, individuals, integrated, intelligence, interactions, interfaces, internet, interoperability, jims, laboratory, link, listen, locally, mist-mg, palantirs, parallel, pertinent, phones, processes, projects, pull_down, pushed, quantifiably, radio, returning, riu, robust, rotting, send, socio, socio-cultural, socio-culutural, sociocultural, sponsorship, stored, structures, submission, task, tons, traditional, turn, uci, ucinet, viewing, vignette, visualization, visualizing
2	65	aid, android, anthropological, application, applications, appropriate, bangladeshi, civ-mil, civilaffairs, collectors, combined, conducts, conjunction, counter-insurgency, curriculum, customized, designed, develop, developing, disseminate, download, ecological, effective, effectively, enables, enabling, examining, faced, focused, framework, geography, goolsby, incorporate, interviews, jctd, know_how, larger, low-bandwidth, makers, map-ht, methodology, military_personnel, mission, mist, mobile_phone, modular, modules, multiple, objectives, partnership, perfectly, platforms, problems, provide_for, researchers, roadmap •, specifications •, store, strategy, suite, suited, tailored, two-way, url, web
3	51	accomplish, addition, analyzed, app, article, commercially, comms-on-availability, connecting, creating, delving, depending, desired, developed, devices, dl, earth, environments, executive, extremely, eyeing, fully, gears, handle, hona, hspda, integrating, involves, iphone, ipod, latest, location-aware, nation, nocom, outputs, productive, protocol, replacement, sna, summary, switched, technical, think_of, touch, untethered, update, usg, variety, vetted, well-rounded, written, xslt
4	44	95th, adaptable, affairs, aims, associated, bde, bigger, brigade, chartered, conducting, demos, employ, enable, engineers, expanding, ft, gater, gator, hand, handheld, held, high-level, ike, incorporated, involving, led, longleys, modifications, module, monkey, multimodal, objective, presentation, project, report, rice, standard, survey, thesis, tigr, v5, v6, visibility, workers
5	43	action, ally, analysts, baa, blur, bottom, bring_about, brings, coasts, core, correspondent, demonstrated, demonstration, departmented, discussion, edges, gear, htacs, instruction, knowledge, lab, labs, layer, leading, management, medcap, medical, national, npss, nsi, of_course, olc, onr, onr-g, overload, phase, professors, program, rdms, regular, trac, visual, wrestling
6	41	american, analyst, anwar, arcgis, arcview, basically, chrome, comma, created, csv, desi, earth , extensible, formats, gis, iron, keyhole, kml, language, light_upon, markup, net , notebook, pajek , palantir , parent, plotting, pxml, rugged, separated, shapefile, shiner, shining, shp, source, text, txt, variable, weve, xml,
7	35	11b, actors, awesome, band, bluetooth, capabilities , cellular, communications, dis, edge, existing, gprs, imagery, infrastructure, leverage, links, local, networking, organizational, paths, prospective, public, ready, secure, server, systems, transfer, transferred, transmitted, unique, usb, utilizes, voice, wifi, wireless
8	34	analysts_notebook, architecture, cdma, cell, cloud, commands, compass, demonstrate, deployable, essentially, exercises, expertise, factor, features, field-based, form, gateway, gps, gsm, impact, in_particular, international, magnetometer, maps, months, network, partnering, products, rdn, releasing, sip, touchscreen, touchscreeninterface, umts
9	31	attempts, compiled, cycle, development, excellent, failures, indonesia, intent, involve, moe, movement, naturally, open_source, opposed, outset, paper, participation, present_day, process, rec, repeated, sites, specialist, speed, studied, terrorism, thai, utilize, vietnam, witnessed, write-up
10	28	advance, commanders, counterinsurgency , counternarcotics, cultural, decisions, depts, disaster, economic, elements, employment, ethnographic, force, humanitarian, humans, informed, insofar, landscape, linkages, mapping , natural, pertains, planning, population, stopping, terrain, transmittal, traveling

The remaining tables for periods 4–15 can be found in Appendix C. As they suggest, the utility of the Clauset, Newman, and Moore (2004) algorithm to discern changes in the conceptualization of the idea over time becomes much more difficult, as the number of words in each group increased substantially. What is visible in the remaining tables, however, are the groupings of common words and phrases that were used to describe the new idea to different audiences over time.

In sum, community detection is useful when applied to the networks that correspond to early time periods (which correspond to fewer nodes and links), but the value of community detection on large text documents decreases as the number of nodes and edges within a network increases. While it does appear that community detection supports the propositions thus far, further analysis is required.

Due to the sheer number of nodes in the top groups, alternative analytic approaches must be applied to the data set to identify and detect changes to the new idea over time as the groupings in the middle of the corpus make it difficult to understand exactly what has changed and what has remained constant. Two such approaches—topic modeling and lexical analysis—are further explored in the subsequent section of the chapter.

C.   TOPIC MODELING

Semantic network analysis helped identify several key nodes and concepts that remained relatively static throughout the corpus. Through the combination of identifying core measures, a communicative power analysis, and finally grouping algorithms, the central description of the new idea appeared to be carefully managed over time. The core words of the new idea did not change much, and any changes to the idea identified in the analysis are reflections of a deliberate reframing of the idea by an entrepreneur into different contexts for different audiences.

Although the semantic analysis identified several core words, it lacked the inclusion of phrases or topics over time. In other words, while the words *data*, *collection*, and *analysis* all appear to be highly central in the corpus, did groupings of these terms change over time? How much did they change and is there a way to compare topics

discussed in period 1 to topics discussed in period 7, 8, 10 etc.? Were other words attached to the core concept that would demonstrate the reframing of the new idea in context? To address this challenge, I turned to topic modeling as a means of answering these questions and moving beyond basic measures of centrality and word groupings.

Topic modeling provides means and methods for automatically organizing, understanding, analyzing, and summarizing a corpus of electronic text. It allows for the identification of themes that pervade the text, facilitates the annotation of themes, and allows for a means of comparing single documents to a corpus to better understand their relationship. Topic modeling assumes that a document exhibits multiple topics. The model learns from the frequency, co-occurrence, and pattern of words within a document, and in the case of the Topic Modeling Tool, compares the topics learned from one document to an entire corpus. Thus, topic modeling provides an altogether different approach to identifying core themes and narratives for this data set. For the topic modeling in this chapter, I used the Topic Modeling Tool developed by Arun Balagopalan.[26]

For this analysis, the total number of *D* documents was 15 which correspond to the 15 time periods for this analysis, and I defined the number *T* topics to find as 10.[27] From these inputs, the topic modeling tool generates the following:

- List of *T* topics

- List of topics in each of the *D* documents

- List of top-ranked documents in each of the *T* topics

Table 38 contains the 10 topics generated using the Topic Modeling Tool.

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[26] The Topic Modeling tool is based on the University of Massachusetts MALLET tool. The source code for this tool is available for download at http://code.google.com/p/topic-modeling-tool/.

[27] 10 topics were chosen as the level for T based on the guidance provided in the MALLET wiki. From the documentation, "Although there is no hard-and-fast rule to set T, it is usually a good idea to take into account the size of the input dataset" (https://code.google.com/archive/p/topic-modeling-tool/wikis/TopicModelingTool.wiki). For this data set, the total number of documents in the 15 time periods were less than 1000, and the recommended topic set ranges between 10 and 20 for this number of documents.

Table 38.   Topics generated using the Topic Modeling Tool

List of Topics	
Topic ID	**Words**
1	capability collected handheld additionally applications geospatial assessment for systems personnel
2	data collection cultural thesis terrain collect process sna report socio
3	networks afghanistan states village relationships training designed fusion products sharing
4	data development collection management real sociocultural operator time module enable
5	data in application devices iphone reports development mist existing coin
6	communities core figure lab district local reports in mohammad combat
7	core lab project program intelligence irregular link source operational marine
8	lighthouse data analytical analytic methodologies task collect collection training amount
9	concept irapids phase application visualization affairs geography server focus population
10	network collection developed to project understanding variety united operational on

In comparison to the central nodes in the semantic network analysis or the frequency distribution of words, the topic modeling output as seen in Table 38 provides an alternate representation of the core ideas for the new idea. In fact, several topics contain the same words (e.g., see the appearance of *data* in topics 2, 3, 4, and 8), but they appear to describe different variants of the new idea.

Topic 1 appears to describe the new idea as a *handheld capability* for *geospatial assessments*. In Figure 19 we see the distribution of Topic 1 over the corpus. In the distribution graphs, we can see that documents from periods 5 and 8 contribute the highest number of words to the topic although documents from each period all contribute to Topic 1. Document 5 includes a large 200-page system description document that was included in a formal proposal to SOCPAC to obtain resource sponsorship. As such, the terms that appear in Topic 1 were prominent throughout this document. Additionally, document 8 includes the Afghanistan prototype testing and feedback documents. Due to the nature of geospatial data collection, it is no surprise these time periods contained Topic 1.
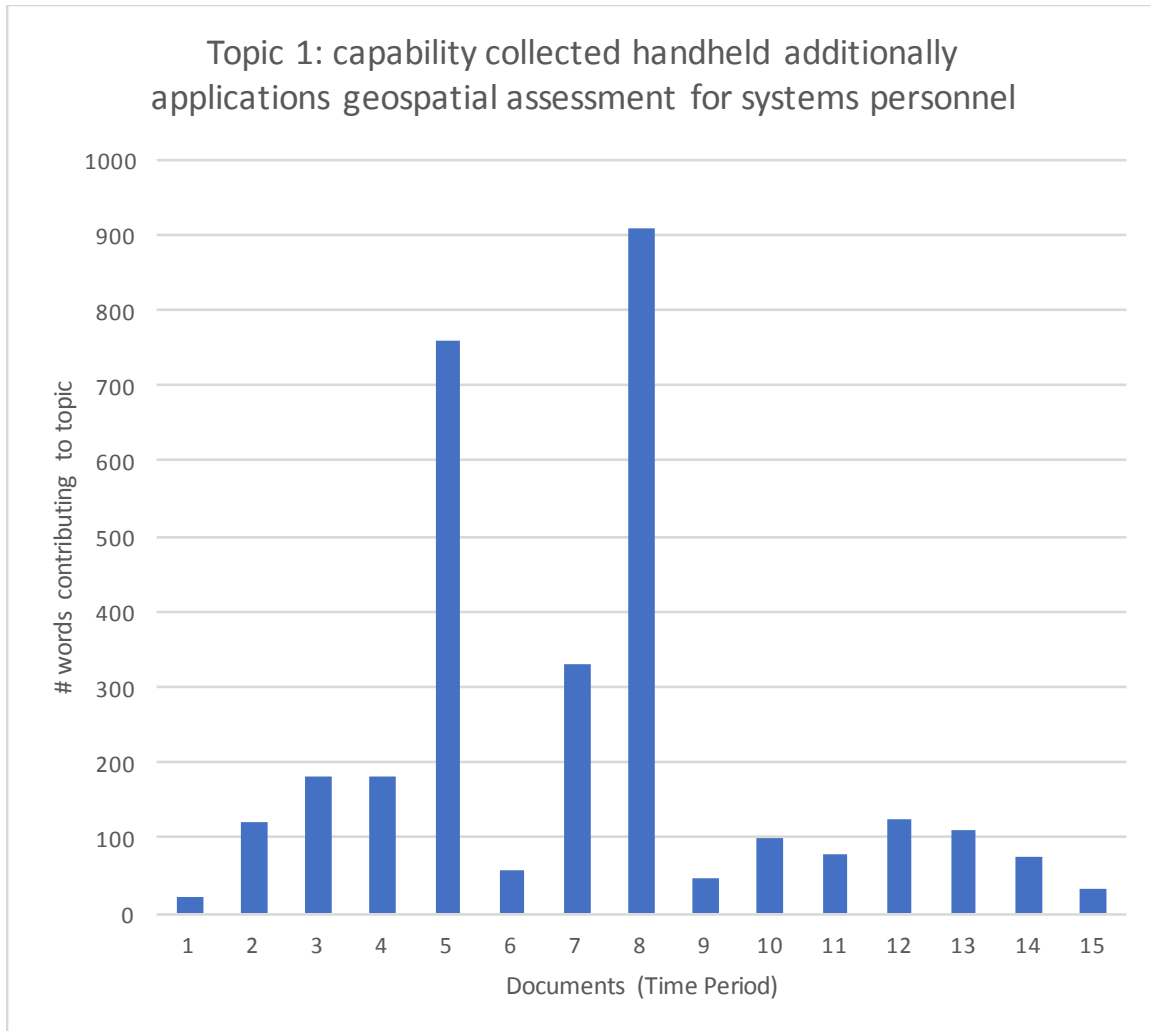
Figure 19.　Topic 1–Document Contribution Over Time

In Figure 20, a slightly different distribution for Topic 2 as we did for Topic 1. As Document 7 corresponds to a period of time which had a significant amount of external communications about the idea including a white paper on the prototype, several research proposals, and a number of briefings to garner interest in the idea. The spike in Period 7 is representative of the repetition of the terms for the *data collection thesis* for *sociocultural* analysis.
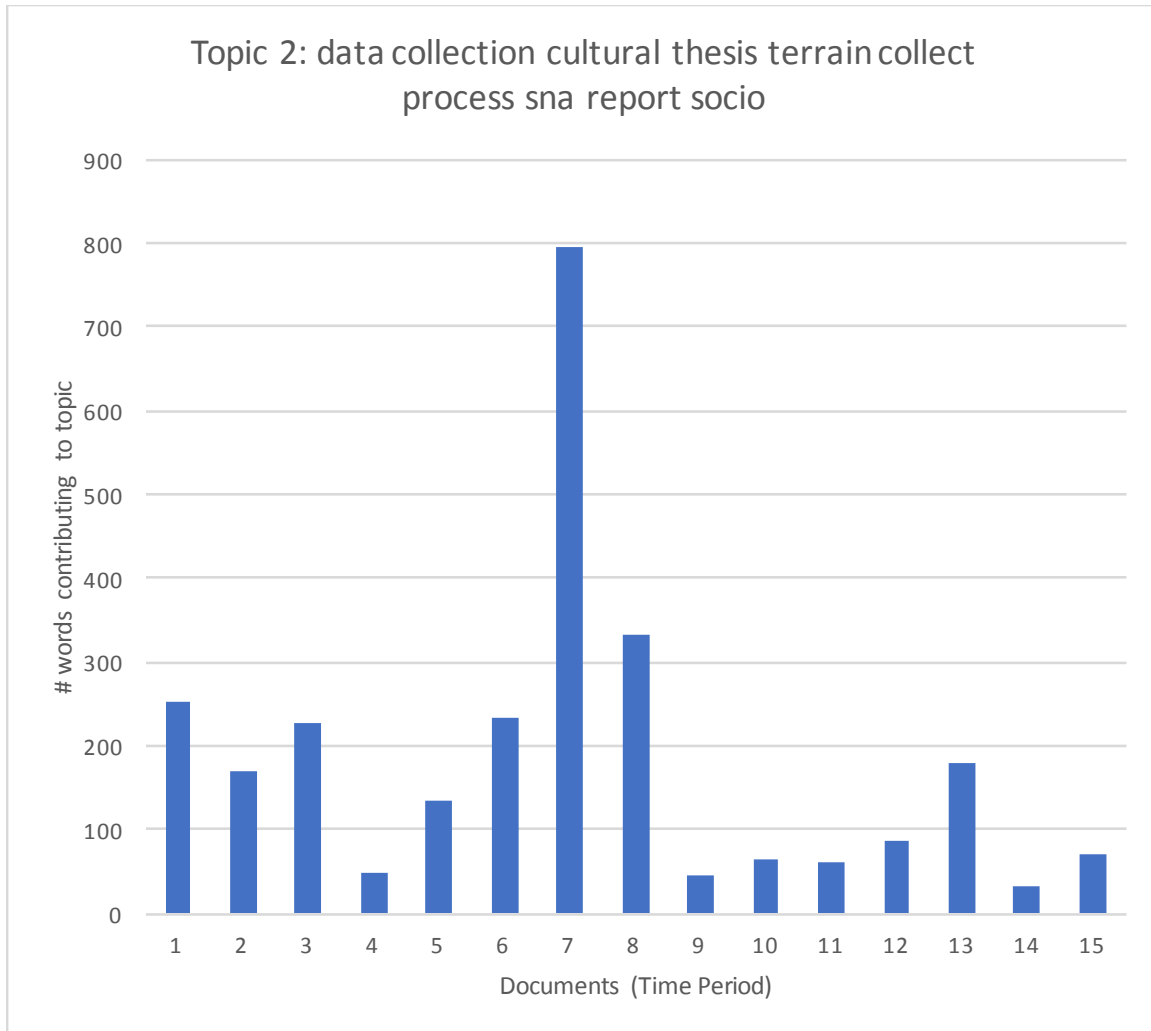
Figure 20.   Topic 2–Document Contribution Over Time

Topic 3 (Figure 21) is most closely associated with the employment of the new idea in Afghanistan and the subsequent briefings and analytic reports related to the employment of the tools in support of VSO in Afghanistan. The heavy contribution from documents 7 and 8 correspond to the system employment in theater and the proof of concept described in the case.

Topic 3: networks afghanistan states village relationships
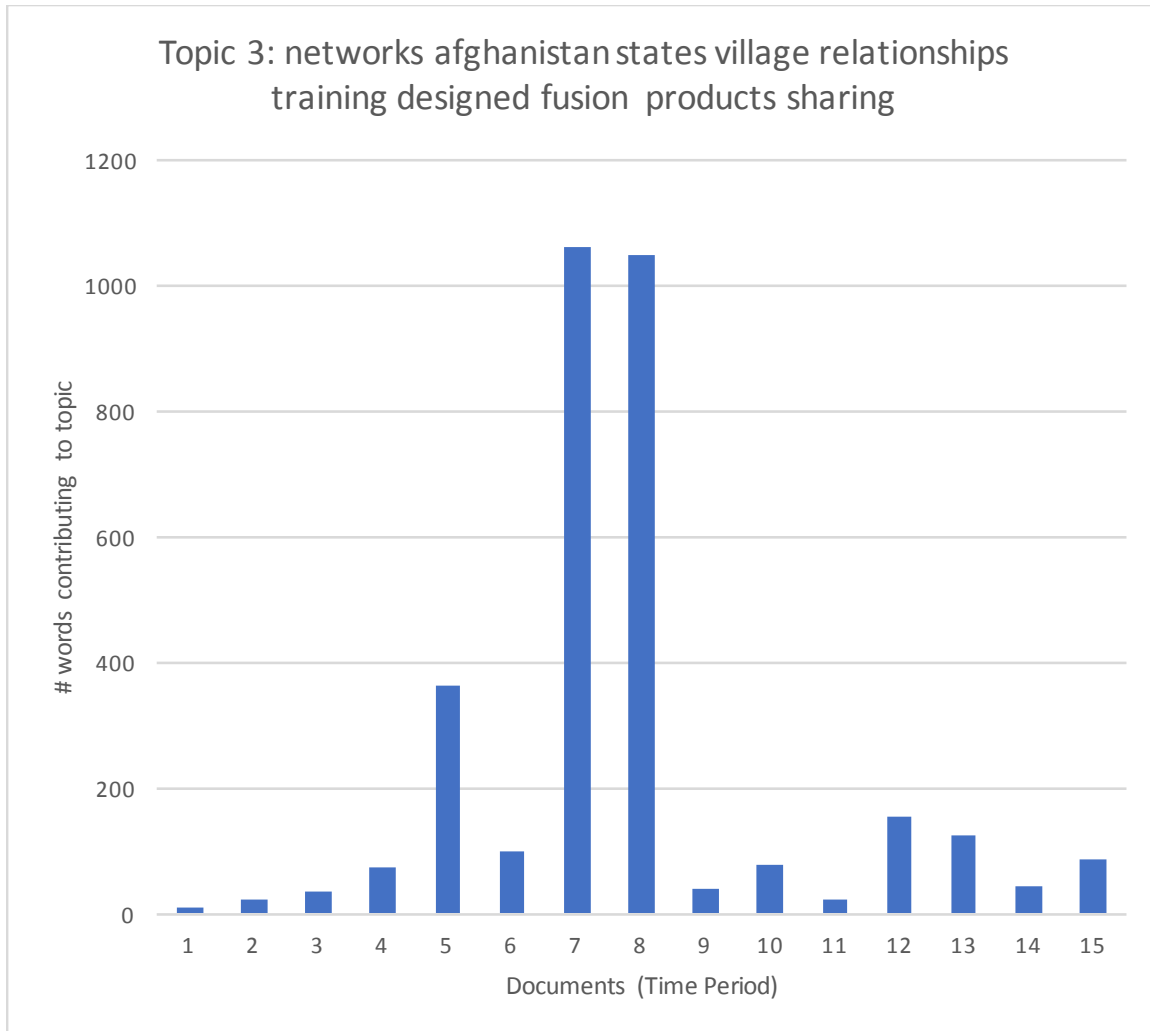training designed fusion products sharing

Figure 21.   Topic 3–Document Contribution Over Time

Figure 22 highlights the distribution of Topic 4 which appears most prominently in periods 4–8. As this topic includes the words *data*, *development*, and *sociocultural*, we do see contributions to this topic from other periods throughout the corpus. However, the focus on *collection management* was an idea that was only articulated for a brief period which corresponds to the uptick in topic prevalence in periods 5, 7, and 8.
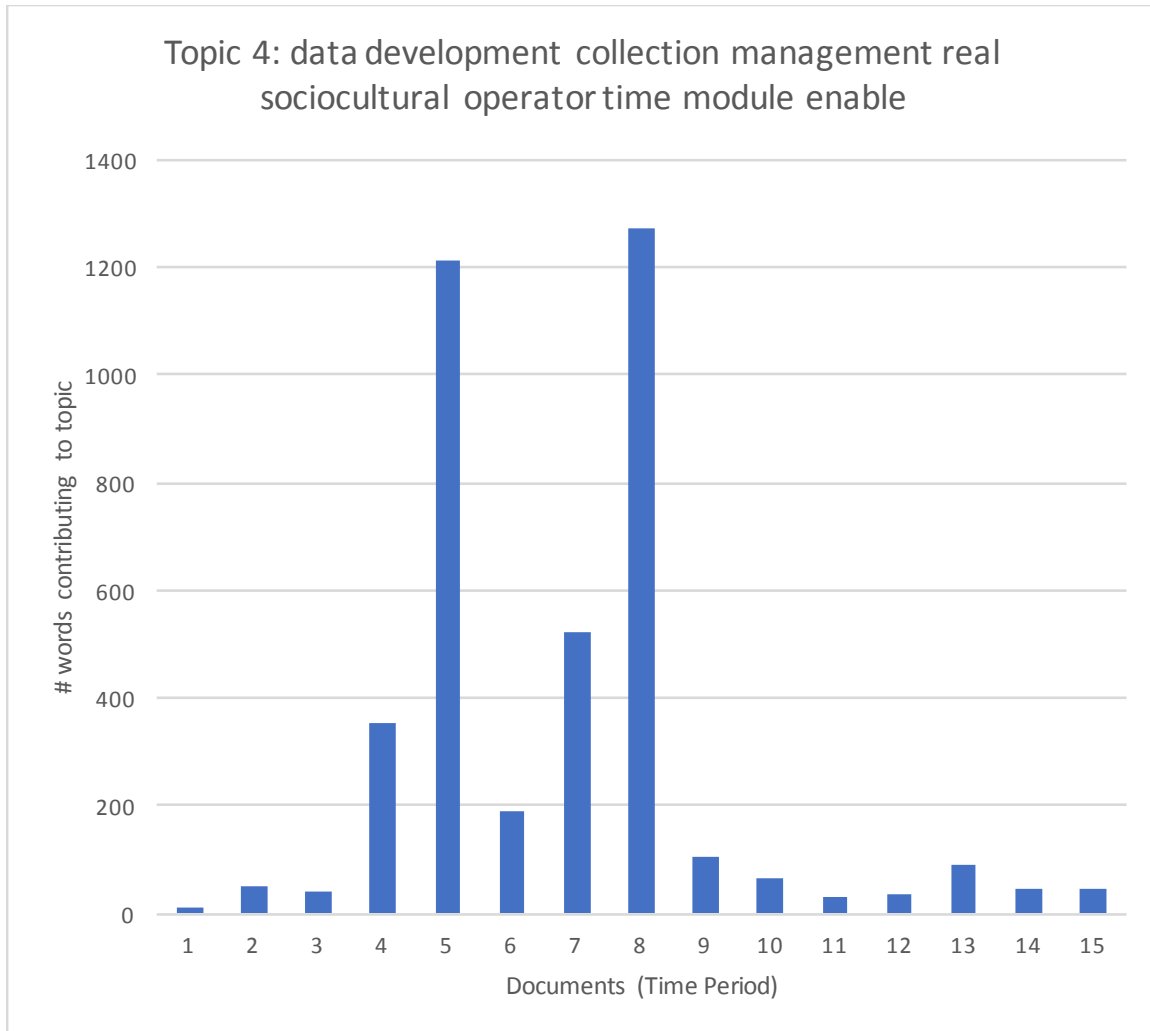
Figure 22.   Topic 4–Document Contribution Over Time

Topic 5 (Figure 23) includes several terms that were prevalent in the earlier days of the new idea's development as the inclusion of *iphone* and *mist* suggest this topic is most appropriately linked to the early ideation related to envisioning the idea as an iPhone application for *coin* (counter-insurgency) purposes.
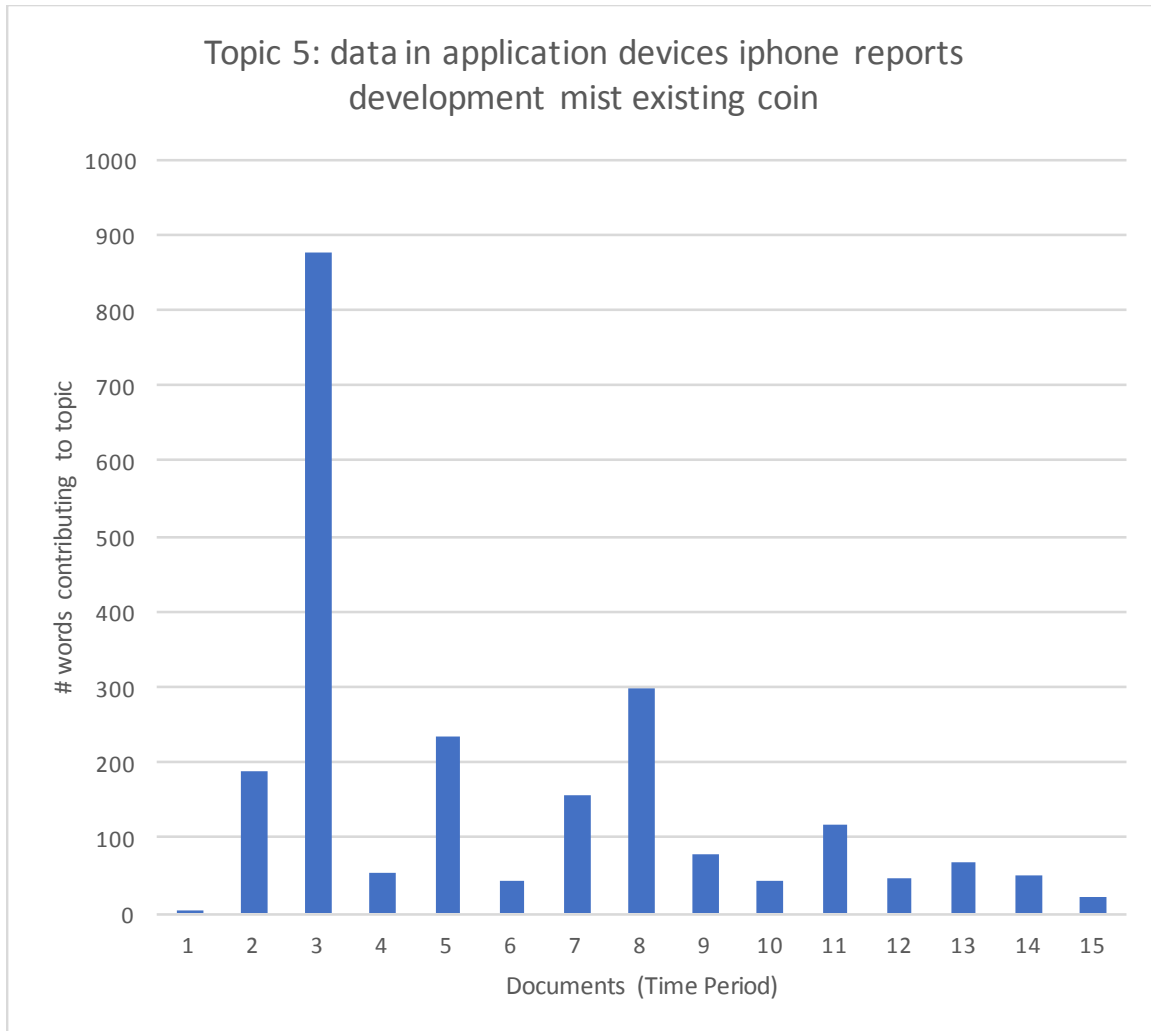
Figure 23.   Topic 5–Document Contribution Over Time

Topic 6 (Figure 24) is dominated by periods 7 and 8 as the district level reports regarding Hajji Muhammad Juma were specific to the Afghanistan proof-of-concept detailed in the case study. The low contribution across the corpus suggests this topic is isolated to a narrow period.
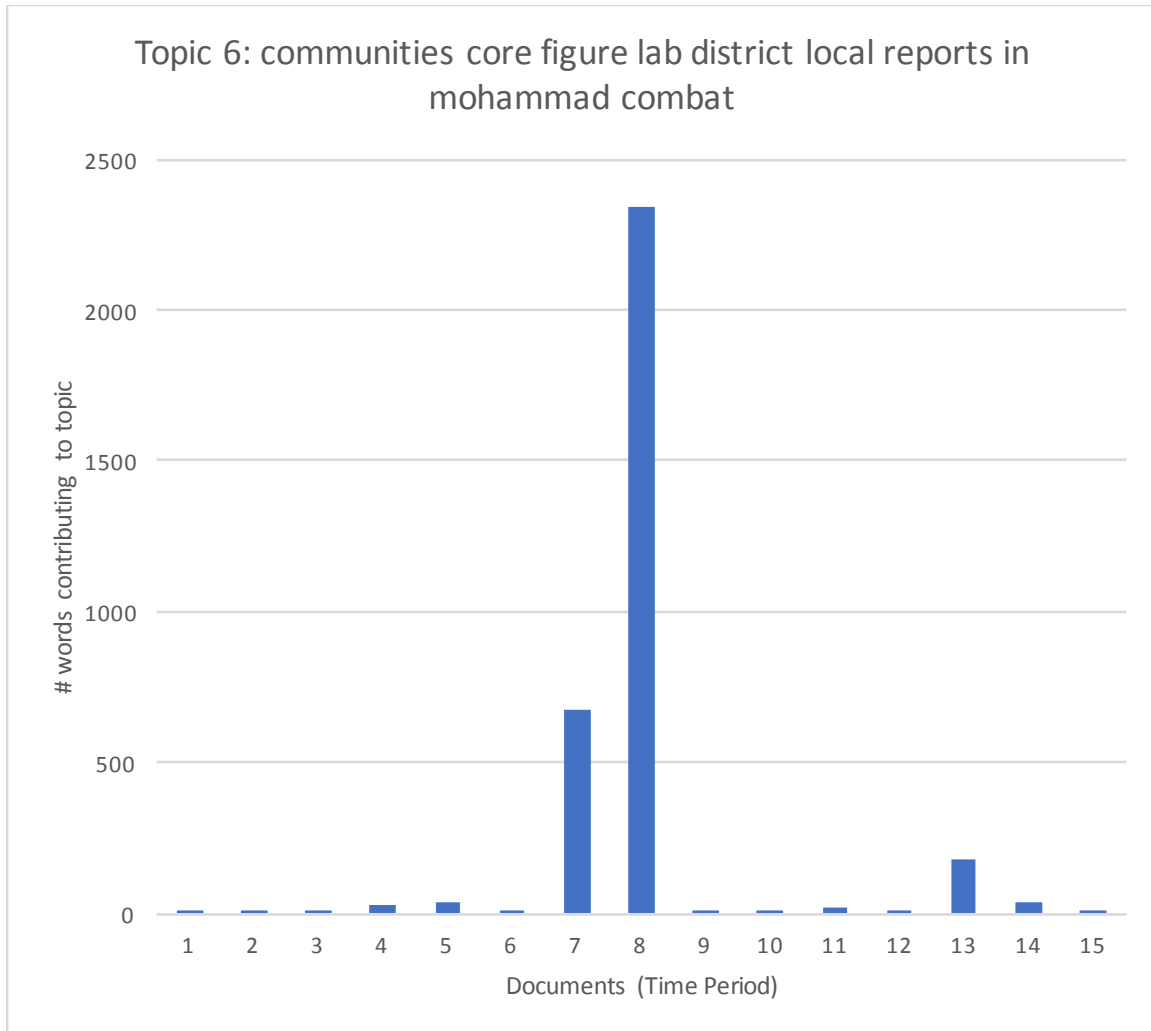
Figure 24.   Topic 6–Document Contribution Over Time

Figure 25 demonstrates the document contribution for Topic 7 throughout the corpus. While the topic has contribution from all the documents over time, periods 7–14 contribute the most to this topic. Since the topic is focused on the *CORE Lab* and the *operational project*, the uptick in document contribution from periods 7–14 aligns closely with the effort to frame the idea to support the CORE Lab's methodology and as an open source project.
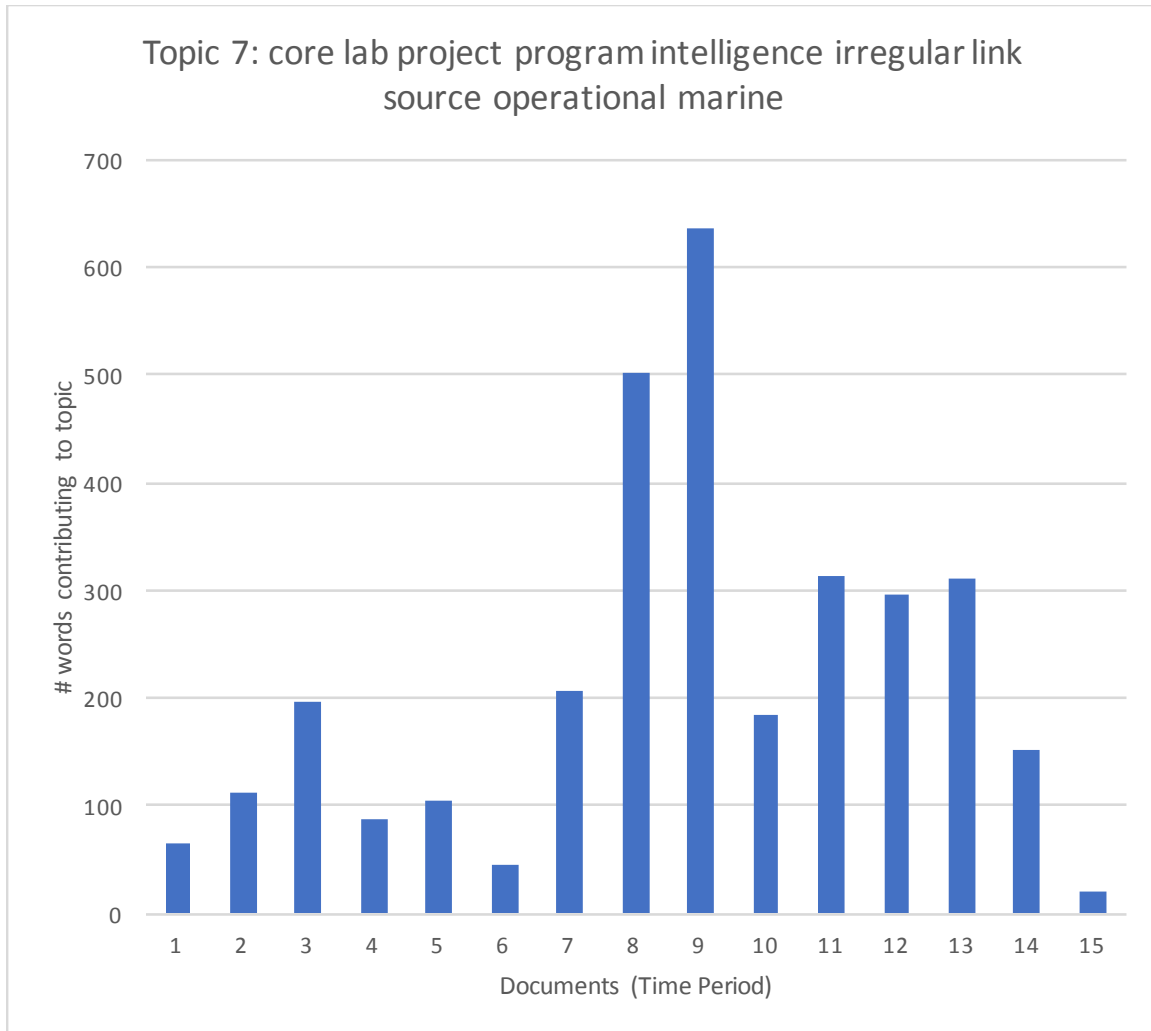
Figure 25.   Topic 7–Document Contribution Over Time

In a similar vein as Topic 7, Topic 8 (Figure 26) highlights the shift in the new idea's narrative from an emphasis on structured data collection for COIN purposes to a *data collection* tool called *lighthouse* that could facilitate *analytic methodologies* and support *training*.

Topic 8: lighthouse data analytical analytic methodologies task collect collection training amount
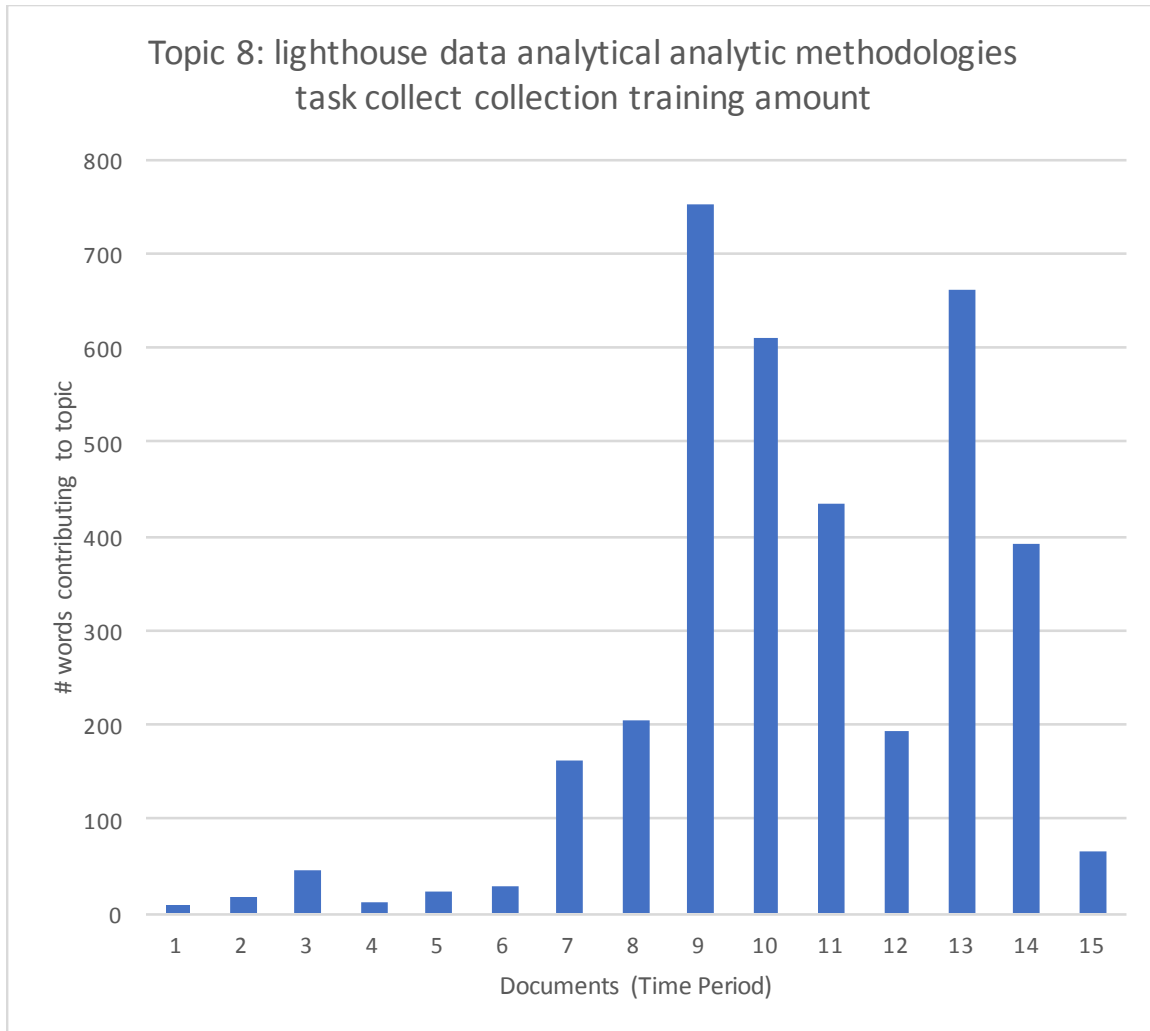
Figure 26.   Topic 8–Document Contribution Over Time

In Figure 27, we can see that the documents that contribute most prominently from to Topic 9 are from periods 4–8. The appearance of *irapids* and *geography* suggest this topic is most closely associated with the framing of the new idea in terms of a tool that is based on the Kestrel Technology Group's iRapids geospatial server. The low level of contribution after period 8 reflects the team split that occurred in late 2010.
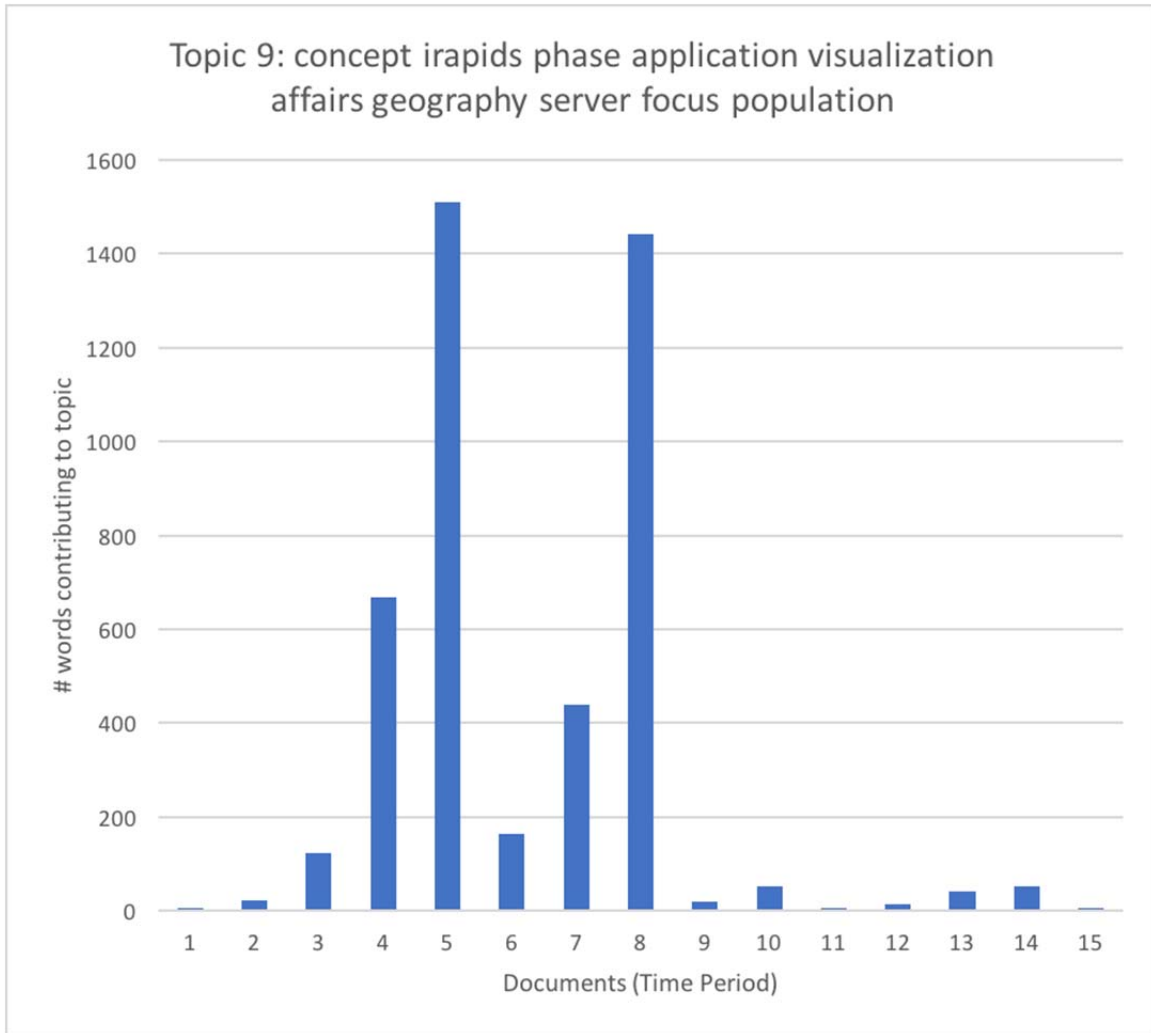
Figure 27.   Topic 9–Document Contribution Over Time

Finally, Figure 28 visualizes the last topic generated from the topic modeling tool (topic 10), which looks to be dominated by periods 5, 7, and 8, although every document in the corpus provides some contribution. The words *network*, *collection*, and *project* and *operational understanding* appear in the topic which would explain the appearance across the corpus as these terms were frequently used to describe the new idea.
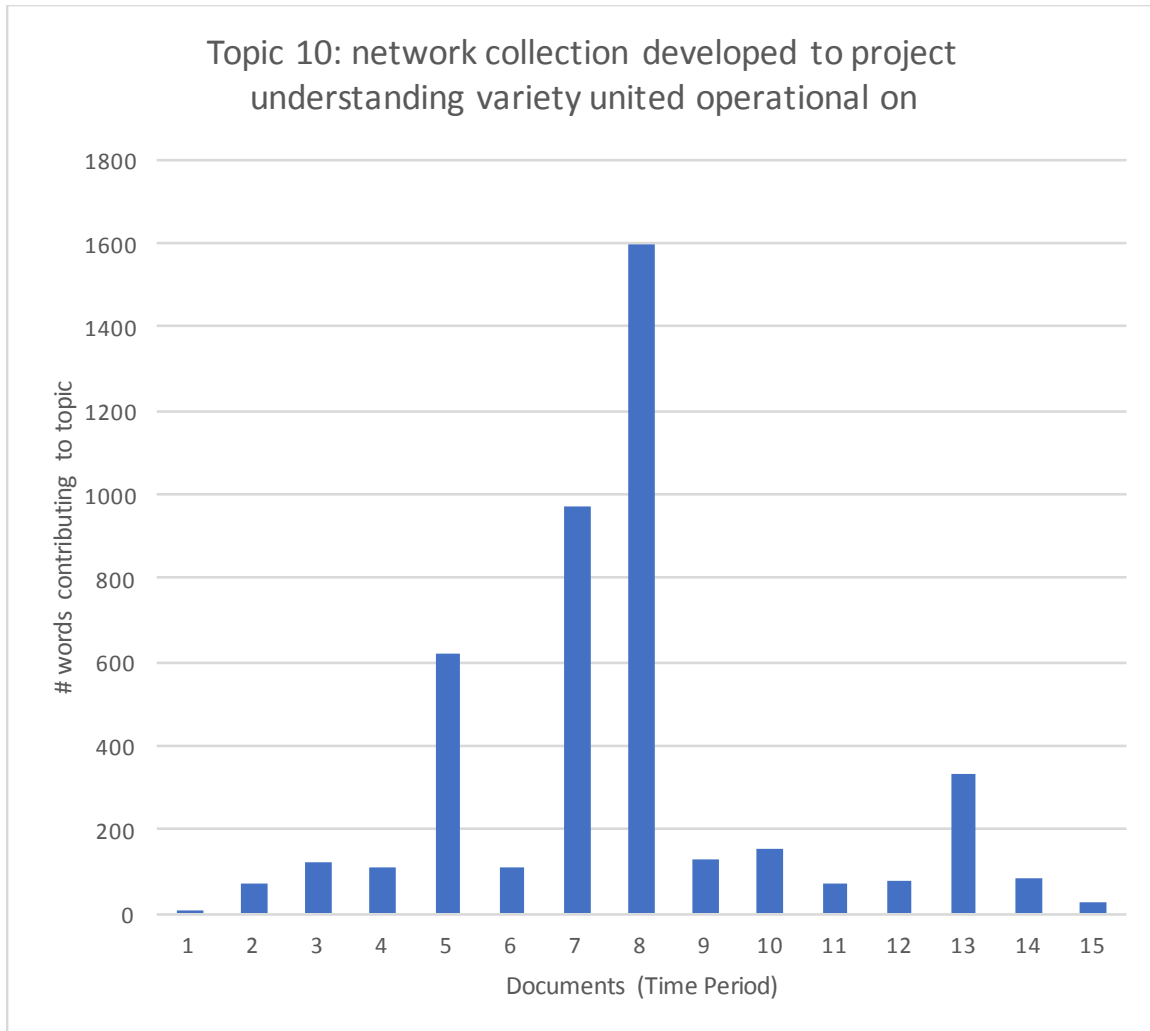
Figure 28.   Topic 10–Document Contribution Over Time

In sum, it appears that several topics persisted throughout all 15 periods (the core idea), although some were more heavily emphasized during specific periods compared to others (narratives used to describe the idea that gained traction with specific audiences). While topic modeling requires interpretation to generate any meaningful insights, the topics that included several of the key words identified in the core network measures—topics 1, 2, 4, 7, 8—appear to most closely match the core idea whereas topics 3, 5, 6, 9, and 10 most closely match different narratives of the idea over time. These findings provide support for both the core propositions and reinforce the semantic network analysis findings in the previous section.

D. LEXICAL ANALYSIS

Since topic modeling can generate topics with overlap (as can be seen using the same terms in various topics), I wanted to identify how similar the documents were to each other using an approach that compares documents to each other over time. Rather than extract topics and identify the proportion of each document that contributed to the topic, this last section of analysis uses various lexical analysis approaches to determine how similar the documents are to each other. We should expect to see documents with a high clustering coefficient (i.e., are more similar) if the central ideas expressed in those documents are similar, and we should see different clusters if the narratives expressed within those documents vary (propositions 1 and 2).

To begin, Table 39 includes descriptive statistics related to each document in the corpus. In this table, each document is described in terms of the number of distinct terms in each document, the number of terms occurring only once in that document, the total term count, and the average term frequency for each document.

Table 39.   Corpus Statistics

Document Name	Number of Distinct Terms	Number of Terms Occurring Once	Total Term Count	Average Term Frequency
1	257	164	377	1.46
2	667	621	732	1.09
3	1455	1234	1810	1.24
4	1404	1321	1551	1.1
5	3680	2995	4753	1.29
6	834	767	921	1.1
7	3749	2996	5028	1.34
8	7491	6279	9490	1.26
9	1063	656	1765	1.66
10	1032	859	1264	1.22
11	990	912	1088	1.09
12	887	834	983	1.1
13	1734	1613	1962	1.13
14	834	761	925	1.1
15	333	318	354	1.06

To better understand how similar documents are to each other, however, we need to understand similarity across documents and not merely within each document. It is to that task that we now turn.

1. Document Similarity Comparisons

In Table 40, each document is compared to every other document within the corpus to determine similarity. Each document is ranked against the remaining 14 documents and a cosine similarity score is provided. The rankings for each document represent a calculated distance between documents after each document has been tokenized and vectorized. The lower the cosine score, the more similar the documents are to each other.

For this analysis, I have chosen to tokenize the documents by bi-grams[28] and use the top 250 terms based on frequency from each document. By culling the documents based on the top 250 terms and by using bi-grams, I wanted to determine how similar documents were across time and if the core ideas within each document persisted throughout the corpus or were discreet in time. In other words, did the core idea of each period change over time?

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[28] A bi-gram is generated from two adjacent words in a text document. I chose to use bi-grams (versus tri-grams or higher) as I was interested in word pairs from the corpus and not large strings or sentences. By choosing bi-grams, I was able to analyze the documents at the smallest unit that was larger than a single word, as was the case for the core network measures.

Table 40.   Document Similarity Rankings

Similarity Rankings

The rankings are determined by 'distance between documents' where small distances (near zero) represent documents that are 'similar' and unlike documents have distances closer to one. Documents were analyzed for bigrams using the top 250 terms.

Doc	1		2		3		4		5	
Rank	Document	Cosine Similarity	Document	Cosine Similarity	Document	Cosine Similarity	Document	Cosine Similarity	Document	Cosine Similarity
1	12	0.3564	3	0.5443	2	0.5443	5	0.5573	6	0.3343
2	8	0.3626	8	0.5581	8	0.5744	8	0.6432	8	0.4905
3	9	0.4813	1	0.5883	5	0.5941	6	0.7096	7	0.5058
4	11	0.5218	7	0.616	1	0.6053	3	0.7174	4	0.5573
5	2	0.5883	13	0.6197	7	0.6298	7	0.7183	3	0.5941
6	3	0.6053	5	0.6326	13	0.6392	13	0.7247	13	0.6164
7	13	0.617	6	0.6678	6	0.6401	15	0.7311	2	0.6326
8	15	0.6444	9	0.7034	15	0.679	2	0.7471	15	0.6348
9	7	0.6758	15	0.7199	4	0.7174	14	0.7873	14	0.6895
10	14	0.7337	11	0.7229	14	0.7308	1	0.7971	1	0.7952
11	5	0.7952	14	0.7301	12	0.7463	12	0.8668	12	0.8217
12	4	0.7971	12	0.7452	9	0.7498	11	0.8859	10	0.8243
13	6	0.8193	4	0.7471	11	0.774	9	0.892	11	0.8505
14	10	0.8289	10	0.7998	10	0.833	10	0.9039	9	0.8852

Doc	6		7		8		9		10	
Rank	Document	Cosine Similarity	Document	Cosine Similarity	Document	Cosine Similarity	Document	Cosine Similarity	Document	Cosine Similarity
1	5	0.3343	8	0.389	1	0.3626	11	0.1408	9	0.3675
2	7	0.4367	6	0.4367	7	0.389	10	0.3675	11	0.372
3	8	0.6012	5	0.5058	13	0.4758	13	0.4477	14	0.4232
4	3	0.6401	13	0.548	5	0.4905	1	0.4813	13	0.5744
5	13	0.6517	2	0.616	12	0.4953	14	0.4814	8	0.7097
6	2	0.6678	3	0.6298	9	0.5078	12	0.4894	7	0.7746
7	4	0.7096	1	0.6758	11	0.525	8	0.5078	2	0.7998
8	15	0.7131	15	0.6964	2	0.5581	2	0.7034	5	0.8243
9	14	0.7166	14	0.7089	14	0.5707	3	0.7498	1	0.8289
10	1	0.8193	4	0.7183	3	0.5744	15	0.7621	3	0.833
11	10	0.8468	12	0.7211	6	0.6012	7	0.7644	12	0.844
12	12	0.8722	9	0.7644	15	0.6236	5	0.8852	6	0.8468
13	11	0.8765	11	0.7679	4	0.6432	4	0.892	15	0.8765
14	9	0.9043	10	0.7746	10	0.7097	6	0.9043	4	0.9039

Doc	11		12		13		14		15	
Rank	Document	Cosine Similarity	Document	Cosine Similarity	Document	Cosine Similarity	Document	Cosine Similarity	Document	Cosine Similarity
1	9	0.1408	1	0.3564	9	0.4477	10	0.4232	13	0.5484
2	10	0.372	9	0.4894	11	0.4502	11	0.4291	14	0.616
3	14	0.4291	8	0.4953	14	0.4558	13	0.4558	8	0.6236
4	13	0.4502	11	0.5238	8	0.4758	9	0.4814	5	0.6348
5	1	0.5218	13	0.6208	7	0.548	8	0.5707	1	0.6444
6	12	0.5238	15	0.7045	15	0.5484	15	0.616	3	0.679
7	8	0.525	14	0.7113	10	0.5744	5	0.6895	7	0.6964
8	15	0.7071	7	0.7211	5	0.6164	7	0.7089	12	0.7045
9	2	0.7229	2	0.7452	1	0.617	12	0.7113	11	0.7071
10	7	0.7679	3	0.7463	2	0.6197	6	0.7166	6	0.7131
11	3	0.774	5	0.8217	12	0.6208	2	0.7301	2	0.7199
12	5	0.8505	10	0.844	3	0.6392	3	0.7308	4	0.7311
13	6	0.8765	4	0.8668	6	0.6517	1	0.7337	9	0.7621
14	4	0.8859	6	0.8722	4	0.7247	4	0.7873	10	0.8765

Table 40 presents the results of the document similarity comparisons. As it indicates, Document 1 (first column) is closest to 12 with a similarity score of 0.3564, Document 2 (second column) is closest to 3 with a similarity score of 0.5443, and so on. If the core concept changed as time passed, we would expect to see documents corresponding to earlier time periods clustered with little overlap with later time periods. This is, in fact, not the case here. Both early and later time periods correlate with each other, and while it is true that some documents in the middle of the corpus closely correlate, the mix of document similarity suggests that the core descriptions of the new idea did not change dramatically over time.

a.   *Dendrograms*

In this section, I provide an alternative visualization of the document similarity and clustering using two common approaches in lexical analysis—dendrograms and Voronoi diagrams.

In the analysis presented thus far, I have made several choices in the analysis to generate the document comparisons. One such choice—to use only the top 250 terms—could bias the results as this narrowly focuses on words and phrases that are often repeated through the corpus. In other words, documents will look more similar if you only focus on a subset of common words and phrases. Additionally, the varying lengths of the documents could also skew the results. To address this issue, I have generated dendrograms for the corpus by including all the phrases in the document first and then compared these results to the dendrogram generated using the top 250 terms.

Additionally, I have provided visualizations using two separate means of calculating frequency and importance of terms—proportional counts and term frequency-inverse document frequency (TF-IDF). The first approach—proportional counts—considers the frequency of term in proportion to the number of terms in that given document. The latter—TF-IDF—takes into consideration the length of a document and attempts to normalize the data.

In Figure 29 (and subsequent dendrograms), each document is plotted on a *leaf* of the graph. Documents that are closely related are grouped into a *stave*. The vertical height between staves provides a visual depiction of how different documents are from each other. In Figure 29, a dendrogram has been generated using proportional counts to compare the distance between document vectors using Euclidean distance. It indicates that documents 7 and 8 are most closely similar, followed by 5. These three time periods closely correspond to the Afghanistan field trials and subsequent communications about the field trials to large audiences. Perhaps more interesting than the document pairs, however, is the relative similarity between a large grouping of documents (between leaf 2 and 13, there is a difference in height of only 0.01824). This large grouping of documents suggests that the content within the documents do not vary greatly over the time periods.

Indeed, because we are focusing on bi-grams within the documents, the document similarity further reinforces the proposition that the core idea remained stable over time.
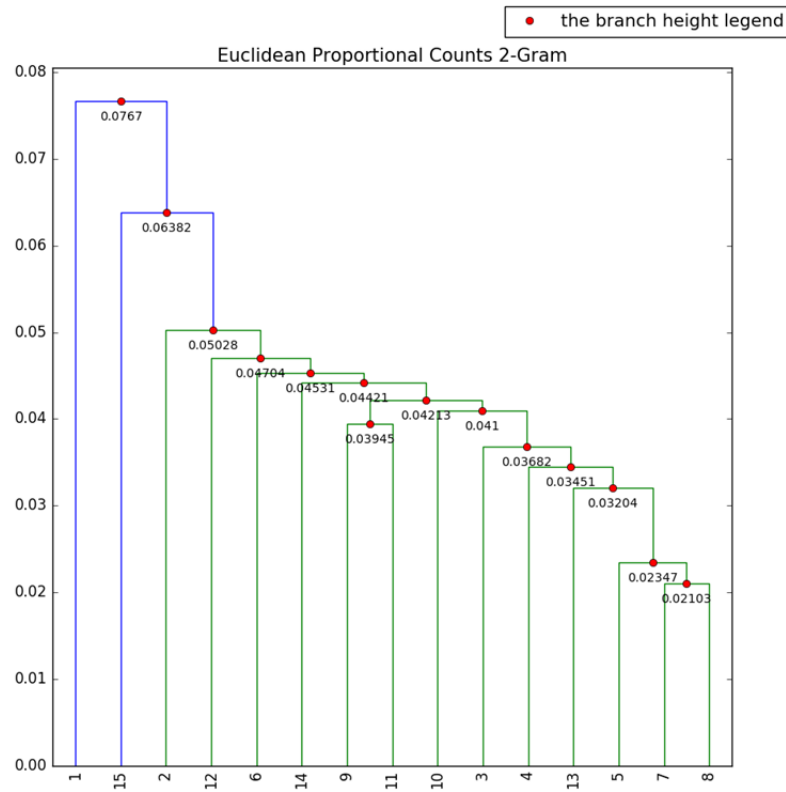

Figure 29.   Dendrogram–Euclidean Distance,
Proportional Counts, Bi-grams

Using TF-IDF, Figure 30 provides an alternate visualization and comparison to the proportional counts approach in the previous figure. While the leaf order has changed slightly, the document similarity and grouping changes little in this visualization. Both figures suggest that while the documents do change over time, the amount of change per period was not as pronounced when the entire document is considered against the corpus.
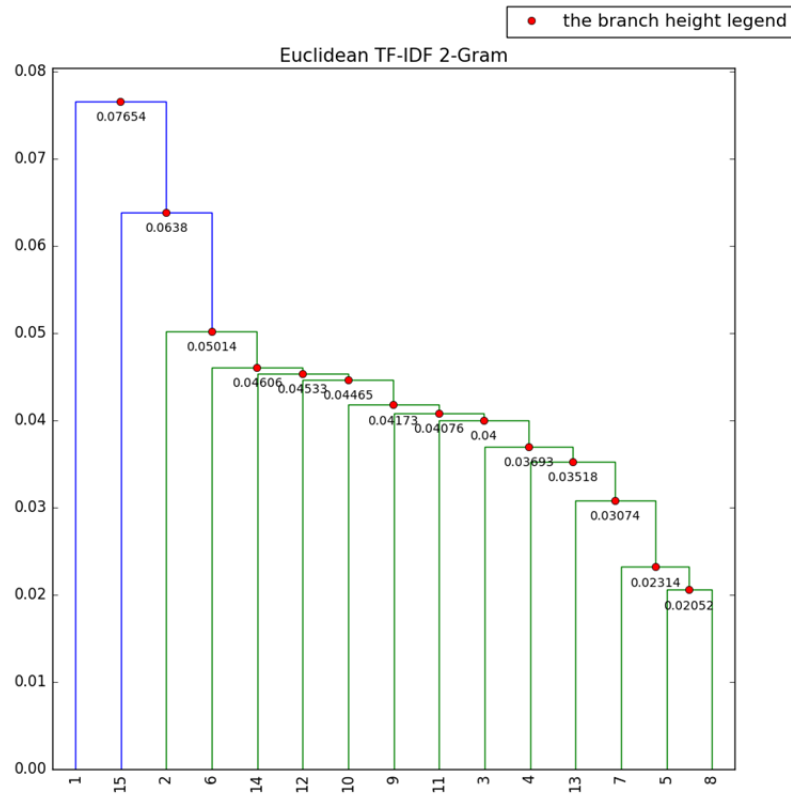
Figure 30.   Dendrogram–Euclidean Distance, Term Frequency–
Inverse Document Frequency, Bi-grams

To compare the previously generated dendrograms that used all terms in the corpus, Figures 31 and 32 are based only on the top 250 terms.
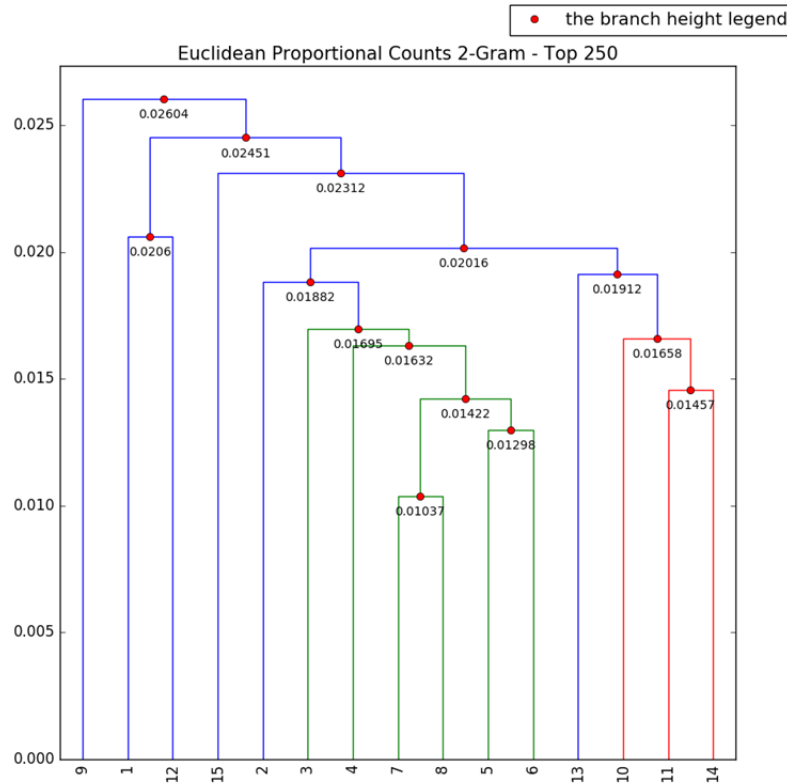
Figure 31.   Dendrogram–Euclidean Distance, Proportional Counts,
Top 250 Terms, Bi-grams

In Figure 31, the vertical separation between documents is much greater than in Figure 29 or 30. This dissimilarity is because it only considers the top 250 terms from each document. Note, however, that the scale for Figures 31 and Figure 32 differ from the previous dendrograms. In fact, the vertical separation in Figure 31 from the top stave to the lowest is only 0.01567. When this diagram is considered in the light of the core idea proposition, we would expect the central idea to appear within the top 250 bi-grams of each document. The lack of vertical separation for the entire graph provides additional support for the central idea proposition.
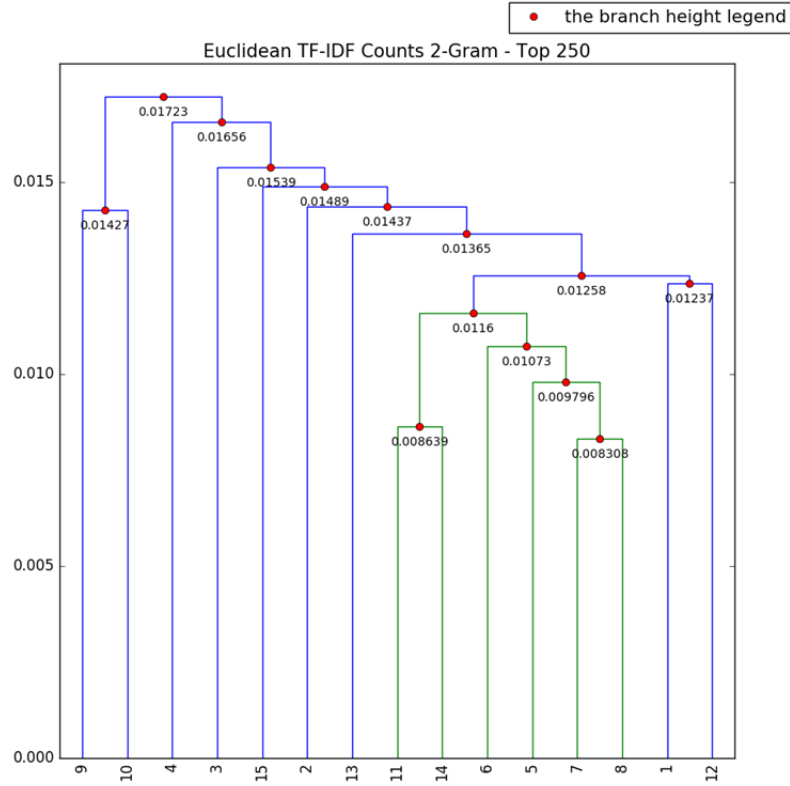
Figure 32.   Dendrogram–Euclidean Distance, Term Frequency–
Inverse Document Frequency, Top 250 Terms, Bi-grams

When the documents are adjusted for varying lengths using TF-IDF, the vertical separation (dissimilarity) is less pronounced. The maximum vertical separation between documents on Figure 30 is only 0.008922, which suggests that the documents are much more similar than they are different. In fact, not only are the documents closely related, but the top 250 terms—what could be alternatively described as the central ideas—are closely related as well and vary little over time.

b.   Voronoi Diagrams

Figures 33 and 34 provide an alternative visualization to the dendrograms provided in the previous section. These visualizations—called Voronoi diagrams—depict document similarity using a clustering algorithm. Each document is clustered using a K-Means clustering algorithm and a composite silhouette score is calculated. Silhouette scores are a measure of fit where a score of 1 indicates tight, distinct clusters and a score

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of 0 indicates overlapping clusters. These scores are plotted on a plane and the distance between points reflects the level of similarity between documents.

Figure 33 highlights the document clustering using all terms and Figure 34 highlights document clustering using only the top 250 terms. Both figures have a silhouette score slightly above 0.5 suggesting the clusters have equal parts overlap and independence. Of note, the clusters generated using K-Means are like those generated using hierarchical means (dendrograms). In Figures 33 and 34, the proximity of documents clustering suggests that the central topics within those documents are closely related—something we observed when visualizing the documents using dendrograms.
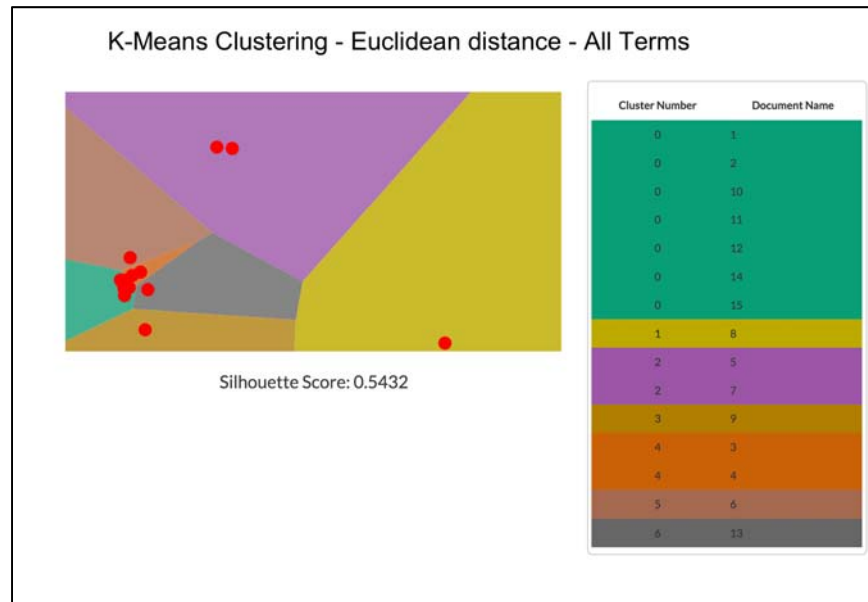

Figure 33.   Voronoi Diagram–K-Means Clustering Using
Euclidean Distance
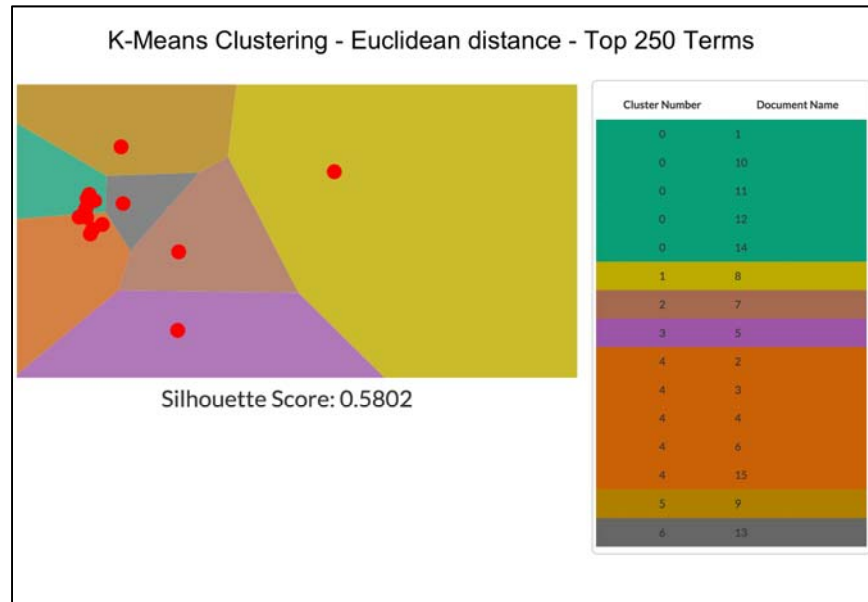
Figure 34.   Voronoi Diagram–K-Means Clustering Using
Euclidean Distance with Top 250 Terms

For both Figures 33 and 34, the close clustering of documents suggests the core ideas expressed within these documents is similar. The number of different clusters is likely attributable to the different narratives describing the application of the idea within those documents.

2.   Core Concepts and Ideas by Document

To better understand how ideas and descriptions persisted over time, Table 41 displays the top words by document (using the top 250 terms) that were determined to be high outliers. In other words, Table 41 represents the top words within a document, compares those words to the corpus, and assigns a statistical value to each word. Those words that are determined to be high outliers (high in terms of standard deviations away from the mean) are displayed in the table.

Table 41.   Top Words by Document–High Outliers (Top 250)

Top Words by Document Compared to Corpus - High Outliers (250 terms)

Top outliers are generated by comparing a document to the corpus using the top 250 terms appearing in the document term matrix.

1 TopWord	Z-score	2 TopWord	Z-score	3 TopWord	Z-score	4 TopWord	Z-score	5 TopWord	Z-score
core lab	6.7132	collection capability	3.688	collection capability	4.095	ucinet pajek	3.5057	conflict assessment	6.2232
marine corps	3.9258	core program	3.1911	data data	3.0977	geography module	3.5057	planning framework	5.0291
collected data	2.8481	data data	2.8149	sociocultural collection	2.8598	data set	2.3057	assessment planning	5.0291
data collected	2.1839	network data	2.7339					proof concept	4.8836
data data	2.1649	marine corps	2.1377					framework tcapf	4.7587
								core lab	-4.4864
								knowledge management	3.4038
								geography module	3.362
								irapids cop	3.2159
								marine corps	-2.9332
								network data	2.808
								data collected	2.6744
								phase phase	2.4751
								handheld collection	2.4751
								ucinet pajek	2.3348
								data collection	2.2981
								combat evaluation	-1.9634

6 TopWord	Z-score	7 TopWord	Z-score	8 TopWord	Z-score	9 TopWord	Z-score	10 TopWord	Z-score
collection reports	6.1156	lines operation	3.8479	evaluation summary	4.8076	core program	5.544	core lab	-2.5805
data data	4.2388	afghanistan pilot	3.718	summary figure	4.8076	analytic methodologies	3.6105	instruction focusing	2.293
fusion portal	3.6041	collection reports	3.7065	combat evaluation	4.6616	data collection	-3.4228	analytic maximize	2.293
ethnographic intelligence	2.1641	hajji mohammad	2.8383	afghan localpolice	4.3219	data collected	-2.815	intelligence analyst	2.293
humanitarian disaster	2.0773	core lab	-2.7672	relational data	-2.7255	instruction focusing	-2.7255	network breed	2.293
core lab	-2.0414	collecting analyzing	2.1128	hajji mohammad	2.5463	intelligence analyst	2.3702	breed analytic	2.293
		mohammad juma	2.0098	lighthouse project	-2.4257	network breed	2.3702	focusing geospatial	2.293
		proof concept	-1.992	marine corps	2.3777	analytic maximize	2.3702	data collection	-2.2058
				core lab	2.3593	breed analytic	2.3702	analyst instruction	2.1931
				fusion portal	2.1691	focusing geospatial	2.3702	maximize investment	2.1931
				analytic methodologies	-2.1494	analyst instruction	2.2593	relational data	2.1315
				core program	-2.1448	maximize investment	2.2593	collection management	2.0143
						core lab	2.2222		
						proof concept	-2.0784		

11 TopWord	Z-score	12 TopWord	Z-score	13 TopWord	Z-score	14 TopWord	Z-score	15 TopWord	Z-score
core program	2.4396	lab methodology	8.7036	lighthouse project	8.8128	analyst instruction	3.3338	knowledge management	3.4246
data collection	-2.2055	core lab	6.5985	analytic methodologies	3.776	maximize investment	3.3338	advanced analytical	2.8481
geospatial temporal	2.1542	relational data	4.2609	advanced analytical	3.2935	concept development	2.6361	operational core	2.2308
		collected data	3.0706	mohammad juma	2.7865	analytic maximize	2.1305	data collected	2.1839
		proof concept	2.4597	ethnographic intelligence	2.0496	instruction focusing	2.1305		
						breed analytic	2.1305		
						intelligence analyst	2.1305		
						focusing geospatial	2.1305		
						network breed	2.1305		

Table 41 provides one of the best views into the description of the new idea over time. In the early time periods (1–4) the idea is best described as a *data collection capability* for *sociocultural data* developed in the *CORE Lab*. In periods 5 and 6, the description changes somewhat to include references to the *assessment planning framework, irapids cop,* and *fusion portal* which correspond to the FIST development as described in the case. Note, however, that even when the top phrases in periods 5 and 6 include the aforementioned words, the persistence of *handheld collection, CORE Lab, marine corps, network data* reinforces the notion that the core idea did not change, but was merely framed differently for other audiences. The central framing of the new idea shifts to the Afghanistan employment as *Afghanistan pilot*, *combat evaluation*, and *ethnographic intelligence* come to the forefront in periods 6–8. As time progresses the

top words return to the original emphasis on *data collection*, *CORE Lab*, and *analytic methodologies*.

In addition to the top outliers see in Table 41, if you compare the top outliers generated to the previous document similarity comparison (Table 40), the document pairs are better understood. As an example, document 1 was most closely related to document 12 from the document similarity comparison. The top outliers from document 1 were *CORE Lab, marine corps, collected data, data collected,* and *data data*. In document 12, these terms were *lab methodology, CORE Lab, relational data, collected data,* and *proof of concept*.

In a similar fashion to the "high outliers" generated in Table 41, Tables 42–43 show the "low outliers" generated from the corpus by document. Due to the size, I have split these into three figures for better readability. Unlike the high outliers, the low outliers are those bi-grams culled from the top 250 terms that are considered outliers above the mean for a document, but are not as pronounced as the high outliers. In other words, if the high outliers correlate closely to the core idea in a period, the low outliers are the words used most frequently to frame the narratives of the core idea. In fact, Tables 41, 42, and 43 reinforce the findings identified in the semantic network analysis and topic modeling. That is, the core narrative of the new idea remained relatively stable across time (proposition 1) whereas the terms used to frame and modify this narrative changed (proposition 2).

As an example, we see a transition from *handheld data* in period 1 to *tribal relations* and *kinship connections* in period 5 while the emphasis on collected data persisted. Similarly, reading the tables by period reads like an abbreviated version of the case study–the initial stages of the new idea were characterized by descriptions of field data collection using handhelds. This idea was later reframed first as a handheld collection tool to support the VSO framework in Afghanistan, and later as a tool to support civil military operations and civil reconnaissance. Finally, the idea was reframed as a tool to facilitate training and reinforce the methodological approaches of the CORE Lab.

Table 42. Top Words by Document–Low Outliers (Top 250)–Periods 1–5

Top Words by Document Compared to Corpus - Low Outliers (250 terms)

Top outliers are generated by comparing a document to the corpus using the top 250 terms appearing in the document term matrix.

1		2		3		4		5	
TopWord	Z-score	TopWord	Z-score	TopWord	Z-score	TopWord	Z-score	TopWord	Z-score
data export	7.9245	terrain collection	14.621	hand held	9.6807	diplomacy development	10.5615	affairs teams	3.3347
handheld data	7.9245	dynamics scd	5.1973	application suite	9.6807	toc server	5.7585	data combined	2.7276
concept concept	4.1002	collection data	4.3971	report multimodal	9.0532	moe mop	5.7585	collecting geospatial	2.7276
		analyst notebook	2.6051	multimodal survey	9.0532	intelligence data	5.1348	geography geography	2.7276
		map terrain	2.6051	mist application	9.0532	isvg cidne	4.8445	hardware knowledge	2.5398
		data export	2.6051	held project	9.0532	pajek arcgis	4.8445	measures performance	2.5398
		handheld project	2.6051	project report	9.0532	real-time data	4.5891	geography affairs	2.5398
		conducted data	2.4158	collection application	5.6539	focused collecting	3.4739	tribal relationships	2.2708
		operational picture	2.2535	handheld project	5.6539	methodology data	3.4739	kinship connections	2.2708
		collection network	2.1122	stored locally	4.3367	concept concept	3.4739	organization traditional	2.2708
				analyst notebook	4.3367	data flow	3.4739	relationships religious	2.2708
				markup language	3.8449	handheld project	3.4739	block application	2.2708
				analyzed variety	2.8923	highly customizable	3.2415	referred context	2.2708
				voice data	2.8923	bidirectional flow	3.2415	connections tribal	2.2708
				conducted data	2.6813			store capability	2.2708
				store capability	2.6813			application map	2.2708
								combined effective	2.2708
								religious education	2.2708
								methods mobilization	2.2708
								traditional methods	2.2708
								collected handheld	2.0793
								configuration data	2.0793
								specialoperations pacific	2.0793
								data storage	2.0793
								engineers researchanddevelopment	2.0793

Table 43. Top Words by Document–Low Outliers (Top 250)–Periods 6–10

6		7		8		9		10	
TopWord	Z-score	TopWord	Z-score	TopWord	Z-score	TopWord	Z-score	TopWord	Z-score
dynamic network	4.7768	fusion view	3.9575	quantitative response	2.9592	adversaries irregular	4.3866	cmo branch	7.3985
gina architecture	3.8076	socio-cultural dynamics	3.6478	core operational	2.7675	strategies action	2.7675	technical representative	2.9614
data exported	3.8076	identified relationships	3.4451	figure nagahan	2.7675	apply advanced	2.945	capability development	2.9614
web portal	3.1603	projects identifying	3.3121	figure adirah	2.7675	mitigation measures	2.7242	chsc members	2.9614
fusion view	3.1603	formats ready	2.9432	depicted combat	2.7675	encountered mitigation	2.7242	gang taskforce	2.7624
disaster response	3.1603	usda agricultural	2.9432	lowy manarah	2.7675	risks encountered	2.7242	lighthouse purpose	2.7624
		collection devices	2.9432			operators collect	2.5256	purpose goal	2.0411
		advanced methodologies	2.9432			purpose goal	2.1327	investment leavebehind	2.0411
		ready proved	2.9432			investment leavebehind	2.1327	task deliverables	2.0411
		green sotf-s	2.9432			task deliverables	2.1327	development intelligence	2.0411
		proved advanced	2.9432			development intelligence	2.1327	lighthouse incorporation	2.0411
		sotf-s usda	2.9432			demonstration development	2.1327	reporting chsc	2.0411
		experience afghanistan	2.9047			detailed accomplishments	2.1327	task conduct	2.0411
		coincide conceptual	2.9047			expended balance	2.1327	expended balance	2.0411
		gained experience	2.9047			indicated reports	2.1327	indicated reports	2.0411
		main capability	2.9047			package technical	2.1327	package technical	2.0411
		depicted coincide	2.9047			monthly reports	2.1327	spatial data	2.0411
		coincides understanding	2.9047			obligated amount	2.1327	monthly reports	2.0411
		exactly coincides	2.9047			inorder create	2.1327	development customized	2.0411
		products depicted	2.9047			development customized	2.1327	effectiveness reviewing	2.0411
		usda experience	2.9047			effectiveness reviewing	2.1327	investment behinds	2.0411
		afghanistan usda	2.9047			investment behinds	2.1327	amount committed	2.0411
		clans unitedstates	2.9047			inreserve amount	2.1327	demonstration development	2.0411
		experience clans	2.9047			amount committed	2.1327	lighthouse phones	2.0411
		capability exactly	2.9047			reporting chsc	2.1327	accomplishments risks	2.0411
		understanding gained	2.9047			accomplishments risks	2.1327	enforcement development	2.0411
		village stability	2.5179			enforcement development	2.1327	amount inreserve	2.0411
		developed operator	2.5179			amount inreserve	2.1327	package unlimited	2.0411
		operator newto	2.5179			financial amount	2.1327	obligated amount	2.0411
		interagency partners	2.3326			package unlimited	2.1327	loan lighthouse	2.0411
		dynamics scd	2.2951			reports detailed	2.1327	reports detailed	2.0411
		sot-s developmental	2.2951			members monthly	2.1327	members monthly	2.0411
		communities district-products	2.0856			complete picture	2.1327	financial amount	2.0411
		district-products developed	2.0856			amount expended	2.1327	measures financial	2.0411
						measures financial	2.1327	amount obligated	2.0411
						amount obligated	2.1327	balance month	2.0411
						balance month	2.1327	conduct focused	2.0411
						conduct focused	2.1327	behinds package	2.0411
						behinds package	2.1327	month indicated	2.0411
						task conduct	2.1327	committed amount	2.0411
						month indicated	2.1327	development lighthouse	2.0411
						committed amount	2.1327	technical reporting	2.0411
						technical reporting	2.1327	source lighthouse	2.0411
						representative intelligence	2.1327	representative intelligence	2.0411
						goal task	2.1327	goal task	2.0411
						leavebehind package	2.1327	leavebehind package	2.0411
								unlimited lighthouse	2.0411

Table 44.   Top Words by Document–Low Outliers (Top 250)–Periods 11–15

11		12		13		14		15	
TopWord	Z-score	TopWord	Z-score	TopWord	Z-score	TopWord	Z-score	TopWord	Z-score
lighthouse data	3.7511	lighthouse core	12.5893	haji mohammad	7.5311	loan lighthouse	3.8789	lighthouse data	13.3082
complete picture	2.8189	training seminar	6.1032	mohammad jumas	3.156	source lighthouse	3.8789	structured data	10.8168
inorder create	2.8189	network network	3.9131	data lighthouse	2.8429	lighthouse phones	3.8789	developed operational	4.1002
lighthouse demonstration	2.6104	collection network	3.7064	homeland consortium	2.6278	development lighthouse	3.8789	data lighthouse	4.1002
visual analytic	2.6104	composition structure	2.169	jumas ego	2.4367	lighthouse incorporation	3.8789	program record	3.8387
training seminar	2.6104	physical terrain	2.169	ego network	2.265	unlimited lighthouse	3.8789		
temporal relational	2.6104	map terrain	2.169			lighthouse demonstration	3.6305		
enables operators	2.6104	data lighthouse	2.169			lighthouse data	3.4145		
operators collect	2.428	developed operational	2.169						
		project lighthouse	2.169						
		apply advanced	2.169						
		develop effective	2.169						
		effective structure	1.9983						
		capturing relational	1.9983						
		enables operators	1.9983						
		analyzing sharing	1.9983						

E.   SUMMARY

In this chapter, I combined three different text analytic approaches to analyze the lead entrepreneur and entrepreneurial teams' efforts to manage the new idea over time and provide support for the two observations generated in the case analysis–the persistence of the central ideas of the innovation and the different frames of reference used to describe the idea for different audiences and different contexts. I began the chapter using semantic network analysis to identify core concepts and links between these concepts within the text. Several words stood out as dominant throughout all periods such as *data, collection, core, lab,* and *sna.* The communicative power analysis provided additional measure to compare the importance of top terms in the networks to the standard network measures. The symbols concept group provided the strongest evidence for a central description of the new idea. The community detection algorithm developed by Clauset, Newman, and Moore (2004) provided an initial look at the emergence of topics from the semantic networks that provide some support for the variance in terms used to frame the application of the idea as it was communicated to different audiences.

Following the semantic network analysis, I leveraged topic modeling to generate 10 topics from the corpus based on the frequency and distribution of words within each document and compared these results to the corpus. From the generated graphs, the distribution of each topic suggests that terms used in early periods appeared in later periods as well. The topic distributions provide additional support for the persistence of the terms used to describe the central idea.

With the document comparison techniques applied in the lexical analysis section, we could compare documents (rather than top nodes or generated topics) against each other to understand the changes over time. Using dendrograms and Voronoi diagrams I provided further support for the similarity of the documents and the concepts within.

The analysis presented in this chapter provides additional support that the lead entrepreneur and the entrepreneurial team described applications (i.e., narratives) of the new idea differently throughout the 15 periods of time to garner interest from different audiences (support for proposition 2), yet the central idea remained constant (support for proposition 1). The central idea—a field data collection tool to support sociocultural analysis—remained unchanged. The different narratives—sociocultural dynamics, civil military operations, village stability operations—were merely reflective of the work the team did to describe and present the central idea to different audiences and the semantic network analysis, topic modeling, and lexical analysis presented all provide support for these two observations.

In the following chapter, I explore the results from both the case analysis and the quantitative analysis and describe these findings as they apply to the innovation and entrepreneurship literature.

VI.   DISCUSSION AND CONCLUSION

Innovation and entrepreneurship are complex processes. The innovation process begins with ideas (initiation). From these ideas, potential solutions are developed to perceived problems during the design stage of the innovation process. Entrepreneurs, supported by a network of individuals and organizations, carefully manage ideas and the communication of these ideas to a variety of audiences to gain support—sponsorship, resourcing, buy-in—to move an idea from concept to implementation. As ideas begin to resonate within an organization, the entrepreneur (or an entrepreneurial team) leverages and builds institutional support for the idea and brings various organizations together to facilitate the transition from the design stage to the implementation stage. When successfully implemented, the idea is routinized within the organization and becomes institutionalized practice.

The case study describes the experiences of a lead entrepreneur and an entrepreneurial team trying to move a new idea from its initiation to its implementation within the DOD. The quantitative analysis probed two case study observations: 1) the entrepreneur and his team managed the idea's core identity and kept it constant throughout and 2) the entrepreneur and his team managed the stakeholder acceptance by varying the narratives used to describe and gain acceptance of the idea as it moved through the innovation process. The quantitative analysis provided strong empirical support to both insights by exploring the archival records and analyzing both core concepts and the descriptive narratives using three different text analytic techniques to explore the semantic changes over time. I now turn to a discussion of the study and probe the two research questions with respect to the analyses conducted in the case and in the quantitative analysis.

A.   DISCUSSION

Recall from Chapter III, this study aimed to address and explore (1) how ideas develop and evolve over time as they move through the innovation process and (2) how entrepreneurs manage the meaning of an idea as it evolves over time. To explore these

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research questions, this study blended a longitudinal case study with quantitative analysis comprised of semantic network analysis, topic modeling, and lexical analysis to explore how an entrepreneur and his team manages an idea through the innovation process. This research takes place within a public-sector organization in which the innovation process was nested: the DOD.

The answer to these two how questions appears to be that ideas develop and evolve because of an entrepreneur's desires to see an idea move through the innovation process successfully. The communication of the idea to both internal and external audiences is not a random process, but a deliberately managed effort to craft the narratives of the utility or value proposition of the idea to different audiences to garner support.

During the process of crafting different narratives and communicating to various audiences, some efforts may gain traction and support whereas others falter or fade out. If you take an aggregated perspective of this activity, it would appear as if the idea is splintering into multiple, divergent paths. The reality, however, is that these splinters are deliberate attempts to garner support for the same idea, albeit using different contexts and narratives to garner support to different audiences. Thus, it suggests that our understanding of the management of ideas in the innovation process needs refinement.

Recall from the literature review, the dominant view of idea management within the innovation literature stems from the work of Van de Ven (1986) and Schroeder et al. (1989). Through their work in the Minnesota Innovation Research Program, Van de Ven and others observed that innovation was often stimulated by a shock to an organization, and an initial idea often splintered into several different ideas during the innovation process. Some of these ideas find traction along the way, and other ideas end their journey prematurely. Throughout the case studies, the role of managers and management is emphasized as playing a critical role in the success and failure of new ideas and the level of analysis is aggregated and removed from the micro (idea) level.

While Van de Ven's views on idea management persist in the innovation literature to this day,[29] this study aims to provide an alternative perspective on the management of new ideas by exploring three key differences from Van de Ven's work—level of analysis, the adoption of an interpretive governance theory approach to innovation, and a mixed-methods approach to studying innovation.

The first difference between Van de Ven's work and this study is the level of analysis. Van de Ven's work on the management of ideas was conducted at an aggregated level of analysis that was removed from the level of the entrepreneur attempting to move an idea through the innovation process. The case studies included in his work view the innovation process from the outside looking in and make broad generalizations about the actions and activities that occur daily with the entrepreneurial teams. By conducting analysis at an aggregate level, many of the complex nuances of idea management at a micro level of analysis are blurred and granularity is lost. In contrast to the aggregate level of idea management, this study is conducting at the idea (micro) level and includes a descriptive exploration of the work of the entrepreneur and his team in managing an idea (case study) and communicating that idea (quantitative analysis) over time.

The second major difference between this study and the mainstream research on the management of new ideas is best understood through interpretive governance. The emergence of interpretive governance theory (Bevir & Rhodes, 2006; Bevir & Richards, 2009) provides an alternative conception that can be applied to the act of managing ideas in the innovation process by explaining the behaviors of individuals through decentered theory. Decentered theory "emphasizes the constructed nature of concepts, actions, and institutions" by individuals and their ability to "create meanings in action." The decentered approach argues "that people confront [these] problems against a background

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[29] As of April 2017, Andrew Van de Ven has been cited more than 61,749 times, 22,931 of which were in the past five years alone. His life-time h-index score (a measure of influence in a scientific community) is 78. His h-index in the past five years is 56. These numbers reinforce the claim of Van de Ven's dominance and contribution to the scientific community in general and the inquiry of innovation in particular. These data were obtained from Google Scholar—accessible at https://scholar.google.com/citations?user=U2FFX2oAAAAJ.

of diverse traditions" (Bevir & Richards, 2009, p. 98). "To decenter is to focus on the social construction of a practice through the ability of individuals to create, and act on, meanings is to unpack a practice in terms of the disparate and contingent beliefs and actions of individuals" (Bevir & Rhodes, 2006, p. 98). "A decentered theory implies that network governance arises from the bottom-up. Any pattern of governance is a product of diverse practices made up of multiple individuals acting on all sorts of conflicting beliefs which they have reached against the background of several traditions and in response to varied dilemmas" (Bevir & Rhodes, 2006, p. 98).

By framing innovation in terms of network governance, the "processes of collaborative innovation are embedded in institutional arenas of interaction that can be analyzed as governance networks. [This] interaction provide rules, norms, routines, cognitive scripts, and discourses that structure the actions of the social and political actors and create particular patterns of interaction that can be analyzed using social network analysis" (Sørensen & Torfing, 2011, p. 860). Thus, innovation—in the eyes of a decentered theorist view—focuses on the "individual actors and the meanings that they are constructing and acting upon" (Osborne & Browne, 2013, p. 311). This study adopts this interpretive governance theory view and applies it to interpret and understand the innovation process. Entrepreneurs carefully and deliberately manage the meanings of the ideas they construct and act upon by communicating and framing ideas during the innovation process. The construction of meaning and narratives during the communication process (Pearce & Cronen, 1980) shapes the innovation process (Bartel & Garud, 2009) and provides a more holistic, granular view of the entrepreneurial activities required to manage ideas over time.

Finally, the third major difference between this study and those found in the idea management literature is the methodological combination of a case study with a quantitative analysis—comprised of semantic network analysis, topic modeling, and lexical analysis—of archival records at the idea level. By combining a case study with the quantitative analysis, I have attempted to minimize bias from the case description as I am both the lead entrepreneur and the researcher. Without the additional analysis in the quantitative analysis chapter, it would be challenging to defend claims of impartiality and

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reliability. By including the quantitative analysis, I am both minimizing bias and reinforcing the interpretations made from the case analysis. Furthermore, I am including a level of detail on a study of innovation that is rarely found within the literature. Due to my unique advantage of being both entrepreneur and researcher, I have been able to include a level of detail not found in studies that operate outside the nucleus of an entrepreneurial team as these studies aggregate the perspective of idea management at a higher level of analysis.

Having now discussed the three major differences between this study and the dominant approach in the literature on the management of new ideas, I now turn to the two major propositions developed from the case analysis and subsequent quantitative analysis about the management of new ideas, not from the traditional perspective found in the literature that suggests ideas splinter into many competing ideas along the innovation path, but rather from a micro-level, bottom-up perspective.

1.   Proposition 1: The Core Idea of the Innovation Remains Constant

In the case description, I described the initial formulation of an idea, originally based on the hybrid tactical network concept (cell over tactical radios), and the subsequent dismissal of this idea after failing to gain interest and traction in this approach. After a somewhat happenstance meeting with the CORE Lab leadership, the concept was reframed to focus not on data transmission but on data collection. From this point forward, the new idea could be described as a mobile field data collection system to support analytic methods. Once the idea for mobile data collection system emerged, the core concept remained consistent.

When variation was expressed about the central concept, it was largely due to technical implementation (e.g., iOS vs. Android; Closed source vs. Open Source), and was not a variation in the core idea. Throughout the remainder of the case description, the core idea was consistent and at the center of the entrepreneurial activity. To further support the findings in the case description, I conducted the quantitative analysis found in Chapter V. This analysis was conducted on the archival communications records of the

entrepreneur and his team and was chosen to provide an alternative methodological approach to analyzing the claim that the core idea maintained stability over time.

In the quantitative analysis, I conducted a visualization of the semantic networks generated from the archived records. The network visualizations increased in complexity over time which correspond an increase in communications activity by the entrepreneur to communicate the idea to different audiences over time. Following the network visualizations, a core network analysis highlighted several nodes that were central to the semantic networks. These terms correspond closely with the terms used to describe the core idea of the innovation. After conducting the semantic network analysis, I identified several key nodes and concepts that remained relatively static throughout the corpus. Through the combination of core measures, a communicative power analysis, and community detection algorithms, I find support for the interpretation that central description of the new idea appeared not to vary over time. In the case description, I described the idea as a mobile data collection system to support analysis. In the semantic network analysis, the terms *data*, *collect*, *sna*, *collection*, and *handheld* all appear to be highly central terms and persist over time.

After the semantic network analysis, I conducted a topic modeling of the archival records. Within the topic modeling, I found additional support for the repetition of the core idea over time. Based on the topics identified, it appears as if several topics persisted throughout all time periods (the core idea).

Finally, the lexical analysis used document similarity measures to compare the different time periods against each other to detect changes to the description and communication of the ideas. If the core concept changed as time moved along, we would expect to see documents in early time periods clustered with little overlap with later time periods. This was, in fact, not the case. Both early and later time periods correlate with each other and while it is true that some documents in the middle of the corpus closely correlate, the mix of document similarity suggests that the core descriptions of the new idea did not change dramatically over time.

From both the case analysis and the quantitative analysis, the evidence suggests the central idea did not in fact change over time. The words used to describe the new idea did not change much over time, and any changes to the idea identified in the analysis are reflections of a deliberate reframing of the narratives by an entrepreneurial team into different contexts for different audiences.

Having provided support for the proposition that the core idea remained constant, why did the core idea remain unchanged through the process? The core idea remained unchanged as it was the result of the entrepreneur carefully managing the idea over time. Innovations are born out of a perceived need that is closely associated with a problem (Tang, 1998). A dissatisfaction with the status quo (March & Simon, 1993) drives an innovator to develop potential solutions to these problems (Lilien et al., 2002). In the case where the central concept behind an idea is viewed by the entrepreneur as the best approach to solving a problem, it should be no surprise then that the entrepreneur carefully manages an idea and strives to ensure the implementation of that idea occurs. When the idea is threatened, the entrepreneur may choose to protect the idea by forgoing resourcing and commercial support (as was the case with the project team split in late 2010) and use any means available to increase the organizational support and buy in for the idea. In fact, the entrepreneur may craft various narratives to describe the idea to different audiences to garner support to continue pushing the idea through the innovation process.

2. **Proposition 2: Narratives Shift over Time as the Entrepreneur and his Team Reframe the New Idea in Terms that are Attractive to Different Audiences**

Turning now to the second proposition regarding the development of different narratives to attract different audiences, I will first begin my identifying the major findings from the case analysis before discussing the support evidence in the quantitative analysis.

As seen in the case description, the new idea was described in the context of a variety of applications to include human terrain mapping, military geography, exercise support, law enforcement, and civil military operations. Each of these narratives was

crafted to garner support—either in terms of resourcing or operational sponsorship—from the relevant communities. These narratives were first grounded in the core concept of a mobile data collection system to support analysis, and then adjusted to fit with the different audiences to make the concept more appealing. In practice, the idea pitch occurred through in-person communications. These presentations would invariably include a PowerPoint brief that would first begin from a "master copy" that would be modified to frame the idea with terms, narratives, and applications that would resonate with the audience.

In terms of the general narrative development path the entrepreneur and the entrepreneurial team took over time, the idea was first framed to support human terrain mapping and military geography. Out of the human terrain narrative emerged a more refined ethnographic intelligence narrative that minimized the negative connotation associated with the Human Terrain System (HTS). The narrative was modified by the entrepreneurial team to highlight disaster response preparedness using language from civil military operations before adjusting back to the language of SOF and Village Stability Operations (VSO) support. Following Afghanistan, the team modified the narrative again to garner funding from the Department of Homeland Security for a law enforcement variant of the idea before finally settling in a narrative for civil military operations where the idea finally transitioned as part of the MARCIMS program of effort.

Each of these narrative streams is discussed in the case description, and each was also present in the communications analysis in Chapter V. Within the semantic network analysis, the appearance of key nodes in the core network analysis of *Afghanistan, VSO, cmo, MARCIMS* all correlate to the narratives and the different target audiences. The communicative power of analysis is further revealed, both in the stereotypes class of terms that appears to closely match the context and framing of the new idea over time, as well as in the symbol class that revealed the identification of *intel*, *scd*, *terrain*, *cim*, *vso*, *gang*, and *methodology*. These symbols closely mirror the narratives used for the new idea in terms that would resonate with specific audiences.

Although the communicative power analysis did provide support for the changes to the narrative to increase attractiveness to different audiences, I followed the semantic

network analysis with topic modeling. While topic modeling provided ample support to the central idea proposition, the 10 different topics that were generated using topic modeling closely resemble the narratives used to describe the idea to different audiences over time. Depending on the period, the emergence of words associated with the target audiences or narrative descriptions can be seen in several of the generated topics.

Finally, the lexical analysis and the generation of the top words by document provided the most revealing evidence to support the second proposition. I have included the results table again in this section for ease of reading (Table 45).

Table 45.   Top Words by Document–High Outliers (250 Terms)

Top Words by Document Compared to Corpus - High Outliers (250 terms)									
Top outliers are generated by comparing a document to the corpus using the top 250 terms appearing in the document term matrix.									
1		2		3		4		5	
TopWord	Z-score	TopWord	Z-score	TopWord	Z-score	TopWord	Z-score	TopWord	Z-score
core lab	6.7132	collection capability	3.688	collection capability	4.095	ucinet pajek	3.5057	conflict assessment	6.2232
marine corps	3.9258	core program	3.1911	data data	3.0977	geography module	3.5057	planning framework	5.0291
collected data	2.8481	data data	2.8149	sociocultural collection	2.8598	data set	2.3057	assessment planning	5.0291
data collected	2.1839	network data	2.7339					proof concept	4.8836
data data	2.1649	marine corps	2.1377					framework tcapf	4.7587
								core lab	-4.4864
								knowledge management	3.4038
								geography module	3.362
								irapids cop	3.2159
								marine corps	-2.9332
								network data	2.808
								data collected	2.6744
								phase phase	2.4751
								handheld collection	2.4751
								ucinet pajek	2.3348
								data collection	2.2981
								combat evaluation	-1.9634
6		7		8		9		10	
TopWord	Z-score	TopWord	Z-score	TopWord	Z-score	TopWord	Z-score	TopWord	Z-score
collection reports	6.1156	lines operation	3.8479	evaluation summary	4.8076	core program	5.544	core lab	-2.5805
data data	4.2388	afghanistan pilot	3.718	summary figure	4.8076	analytic methodologies	3.6105	instruction focusing	2.293
fusion portal	3.6041	collection reports	3.7065	combat evaluation	4.6616	data collection	-3.4228	analytic maximize	2.293
ethnographic intelligence	2.1641	hajji mohammad	2.8383	relational data	-2.7255	data collected	-2.815	intelligence analyst	2.293
humanitarian disaster	2.0773	core lab	-2.7672	hajji mohammad	2.5463	instruction focusing	2.3702	network breed	2.293
core lab	-2.0414	collecting analyzing	2.1128	lighthouse project	-2.4257	intelligence analyst	2.3702	breed analytic	2.293
		mohammad juma	2.0098	marine corps	2.3777	network breed	2.3702	focusing geospatial	2.293
		proof concept	-1.992	core lab	2.3593	analytic maximize	2.3702	data collection	-2.2058
				fusion portal	2.1691	breed analytic	2.3702	analyst instruction	2.1931
				analytic methodologies	-2.1494	focusing geospatial	2.3702	maximize investment	2.1931
				core program	-2.1448	analyst instruction	2.2593	relational data	2.1315
						maximize investment	2.2593	collection management	2.0143
						core lab	2.2222		
						proof concept	-2.0784		
11		12		13		14		15	
TopWord	Z-score	TopWord	Z-score	TopWord	Z-score	TopWord	Z-score	TopWord	Z-score
core program	2.4396	lab methodology	8.7036	lighthouse project	8.8128	analyst instruction	3.3338	knowledge management	3.4246
data collection	-2.2055	core lab	6.5985	analytic methodologies	3.776	maximize investment	3.3338	advanced analytical	2.8481
geospatial temporal	2.1542	relational data	4.2609	advanced analytical	3.2935	concept development	2.6361	operational core	2.2308
		collected data	3.0706	mohammad juma	2.7865	analytic maximize	2.1305	data collected	2.1839
		proof concept	2.4597	ethnographic intelligence	2.0496	instruction focusing	2.1305		
						breed analytic	2.1305		
						intelligence analyst	2.1305		
						focusing geospatial	2.1305		
						network breed	2.1305		

In the early time periods (1–4) the idea is described as a *data collection capability* for *sociocultural data* developed in the *CORE Lab*. In periods 5 and 6, the description

changes somewhat to include references to the *assessment planning framework, irapids cop,* and *fusion portal* which correspond to the FIST development as described in the case. The persistence of *handheld collection, CORE Lab, marine corps, network data* reinforce proposition 1 and proposition 2—the core idea did not change, but the narrative was framed differently for other audiences. The narrative shifts to the Afghanistan employment as *Afghanistan pilot*, *combat evaluation*, and *ethnographic intelligence* come to the forefront in periods 6–8. As time progresses the top words return to the original emphasis on *data collection*, *CORE Lab*, and *analytic methodologies*.

From both the case analysis and the quantitative analysis, the variance of narratives used to describe the new idea and attract different audiences is clearly present. While the innovation literature does not provide a clear response to why different narratives would be crafted, the need to garner support for an idea (Kijkuit & Van den Ende, 2007) may best be understood in terms of design thinking which uses problem definition, ideation, and empathizing with end users to increase buy-in, obtain resourcing, and generate support for an idea (Strehlow, 2005).

B. REFINING THE FRAMEWORK OF ENTREPRENEURSHIP IN THE DOD

Entrepreneurship is a collective process. It is especially true of large public bureaus like the DOD. While one entrepreneur can generate an idea, it takes a team of entrepreneurs and a community of supporters to launch an idea into practice. During the case, it took nearly four years from conceptualization to implementation for the mobile data collection idea. The idea's implementation into the MARCIMS program was a mark of success for the implementation of the idea. The role of the entrepreneurial team in carefully managing the core concept of the idea and the narratives used to describe and build support for the idea were critical to the success of the innovation.

This perspective of innovation suggests the difficulty in innovating in the DOD is more nuanced than simply acknowledging a bottom-up versus a top-down dichotomy in the innovation framework (Roberts & Longley, 2013). In the DOD, the alignment between both the management structure and the entrepreneurs is incredibly challenging

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and resource intensive. Given the sheer number of stakeholders, organizations, policies, and resources required for successful innovation in this case, it should be no surprise as to why it is so challenging for the organization to innovate at all. The continued reliance on external organizations to develop new technologies and approaches is testament to the difficulties of innovating in house.

In the case, bottom-up innovation is clearly present with the actions and activities of the entrepreneur, his team and their support network. The incorporation of multiple organizations and people who had top-level authority suggests that the bottom-up and top-down innovation model is accurate, but does not completely capture the phenomena. By studying the communication of an idea over time as it proceeds through the innovation process (semantic network analysis, topic modeling, and lexical analysis) and the actions and activities of an entrepreneur and his team to bring the idea into implementation (case description), we begin to see that successful innovation in the DOD is contingent on the successful balancing of both processes and on the deliberate actions of the entrepreneur in managing ideas over time. Whereas previous studies explore the management of new ideas at an aggregate level, this study provided a unique exploration of the phenomenon at the idea level—a unique feature of the study that differentiates it from other innovation studies.

C.   MAJOR CONTRIBUTIONS OF STUDY

This study provides a unique, bottom-up perspective of innovation in the DOD that tracks the development of an idea through the innovation process and the entrepreneurial activity required to bring the new idea into existence in the DOD. This refined, bottom-up perspective of the innovation process is unique in the literature in that it has explored both the evolution of an idea over time and the actions of an entrepreneurial team and the social networks to manage the communication of an idea over time. The case study provided context for a communications analysis of archival records related to the case. By combining a case study that highlights an entrepreneur's activities in bringing an idea into existence and the communication of that idea over time,

this dissertation provides a unique methodological approach that may provide future researchers a model to use for studying the innovation process.

Within this study, I have addressed how the core ideas behind a new idea remain consistent, and how an idea is communicated to different audiences for different purposes using different narratives to describe the value proposition to those audiences. This study has provided empirical support to the generated propositions about the management of new ideas over time and has informed a refinement to a bottom-up innovation framework within the DOD. While this model is based on a single case within a specific organization, the observations made in this study are likely applicable to other innovation studies within the public and private sectors.

The propositions from this study have provided insights into the management of innovation, not from the traditional perspective of formal management within an organization, but from the perspective of an entrepreneur and his team in managing the idea itself. This perspective of idea management provides a unit of analysis that is often missing in other innovation studies as it exists at a micro level, rather than at the aggregate level of traditional innovation research. While the two propositions that were generated from this study provide insights based on the three conditions in the study— public sector, DOD, and bottom-up—they have not yet been integrated into theory and further exploration and testing in other contexts is required.

D.   FUTURE RESEARCH

In this section, I will highlight two additional areas that can be addressed in future innovation research which will provide additional insights and understanding that may alter the findings from this dissertation. The two suggestions–the exploration of the role of the entrepreneur in other public sector organizations and the incorporation of additional analytic methods to explore the interactions of the entrepreneur—are detailed below.

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1. Explore the Role of the Entrepreneur in Other Public Sector Organizations

This study focuses on the role of the entrepreneur and his team in managing an idea in a specific organizational context—the DOD. While the experiences of this entrepreneurial team are likely not unique, the role of an entrepreneur and his team in managing the meaning of ideas should be tested in other public sector organizations to examine how, and under what conditions, an entrepreneur can maintain control over the management of an idea. In this case, the NPS provided a unique environment in which the creation, development, and communication of an idea and the narratives used to describe the idea took place within a research setting where the entrepreneurial team maintained control over the idea for an extended period. Other public sector organizations outside of a research-based, academic environment may not afford the same level of control or time horizon as did the NPS.

2. Use Additional Analytic Methods to Explore the Interactions of the Entrepreneur

This study has focused on the communication of an idea over time by analyzing the archival records generated by the entrepreneur and his team to communicate the idea to different audiences and organizations. As innovation is viewed as a collaborative effort (Sørensen & Torfing, 2012), adopting additional analytic methods such as social network analysis will allow researchers to understand the evolution of an idea and communication of that idea through the networks in which an idea is nested. Due to time constraints, the exploration of the innovation process within this study has not addressed the social networks of the entrepreneurial team and their supporters within the broader organizational context.

E. SUMMARY

In this chapter, I have expanded on the results generated from the case analysis and the quantitative analysis by using an integrative approach to develop two propositions about the management of ideas in the innovation process. These propositions address gaps in the literature and suggest utility in the mixed-methods approach

conducted in this study. The methods used in this study has enabled a deeper understanding of the innovation process by stage, informed by a relational perspective, and explores the interaction between the development of an idea and the entrepreneurial activity required to move an idea through an organization over time. The use of the case study allows for a deeper contextual understanding of innovation that what can be ascertained using a case study alone, and the quantitative analysis provides empirical support to the insights generated from the case study.

This blended approach has helped to answer the research questions of the study and has provided both an alternate view of the management of new ideas and a unique methodological approach with which to study entrepreneurship and innovation. The propositions generated have added and refined our understanding of the innovation process within the DOD. This refined framework should now be tested empirically through subsequent research by further exploring the entrepreneurial processes using additional analytic techniques such as social network analysis to explore not only the communications and management of an idea, but the network of relationships used to facilitate moving an idea from concept into practice. Additionally, future research should test the generated propositions to determine applicability and utility in other contexts.

F. CONCLUSION

Ideas are moved through the innovation process in a complex and often circuitous route, not by random chance, but by the deliberate actions of individuals that carefully manage and communicate the ideas to garner support. While previous studies have demonstrated how ideas evolve over time at an aggregated level of analysis (Schroeder et al. 1989), this study has demonstrated that entrepreneurs carefully manage ideas and are just as important to the innovation story.

Innovation is championed as the solution to a variety of problems the DOD faces, and implementation of innovation within the Department is challenging. Studies of military innovation acknowledge the difficulty of innovating within a bureaucratically inflexible and change-resistant organization. In an organization where guidance and direction are provided from the top down, whereas ideas and new tactics, techniques, and

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procedures are developed from the bottom up, how does the Department organize, foster, and encourage innovation effectively? This study provides an empirical study of bottom-up innovation within the DOD that provides valuable insights into the innovation process and acknowledges and incorporates the importance of entrepreneurs in the management and development of new ideas over time. Successful innovation in the DOD must be studied with respect to both the entrepreneurs and their support networks needed to enable the innovation process.

This study has provided an example of how the top-down desires for innovation can be supported by the enterprising, entrepreneurial spirit and the efforts of those who push their ideas and concepts from the bottom up. The development of propositions regarding idea management enhances the existing knowledge base on innovation, yet further testing in subsequent studies is required before we will achieve a fully developed and refined theory for the management of new ideas. Subsequent studies should carefully approach the study of innovation by clearly addressing the interrelated processes of innovation and entrepreneurship, as each plays a separate but related role in bringing innovations into existence. Future research also needs to delve deeper into idea management beyond an aggregated view that characterizes much of the research. If specific ideas matter, then so do the day-to-day actions of the entrepreneurs who give life to the idea and forge it into organizational practice.

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APPENDIX A. SOCIAL NETWORK ANALYSIS

Social network analysis (SNA) is a series of methods that enable a common approach for describing the structure, spatial properties, and units of analysis of a network (Table 43). A modern derivative of Gestalt theory, socio-metrics, group dynamics, graph theory, and structural anthropology, SNA systematically analyzes and describes social networks using computational processes (Scott, 2000). Its primary focus is "on ties among, for example, people, groups of people, organizations, and countries" (de Nooy, Mrvar, & Batagelj, 2005, p. 1).

While networks can be composed of different types of objects, all networks can be visualized. Visualizations are arranged in patterns based on a variety of algorithms that produce different layouts. Some algorithms allow for viewing a network in a hierarchical layout (such as an organization chart), others allow for nodes with high scores on certain metrics to be arranged in the center of the graph, and still others control the attraction or repulsion of the nodes in the graph (Scott, 2000). As a computationally rigorous method for describing the various properties and characteristics of nodes and relationships within a social graph, SNA is conducted using various computer software packages. In this study, ORA was used to create the visualizations and reports.

Table 46.   Network Analysis Terms and Definitions. Source: Coulon (2005).

Network Analysis Terms	Definitions
Node	The basic element of a network
Tie / Edge	A set of two nodes. Ties can be dichotomous (unweighted) or weighted/valued, directed or not (undirected)
Directed Tie	An ordered set of two nodes, i.e., with an initial/source and a terminal/destination node
Network	A set of nodes connected by a set of ties
Valued Network	A network whose ties/edges are associated with a measure of magnitude or strength
Ego	A node which receives particular focus
Alters	The set of nodes that has ties with the ego but not including the ego itself
Network Size	The total number of nodes of a network
Relational data	The set of ties of a network

A network is formed by the relationships people have with each other (e.g., kinship, friendship, business, communication, and trust), as well as in relation to social structure (e.g., belonging to, member of). These relationships—ranging from kinship ties, communication ties, interaction ties, and even co-authorship ties—provide context for and define a network.

(1)   Visualization and analysis

While networks can be composed of different types of objects, all networks can be visualized using a common approach borrowed from graph theory. In a network visualization, the graph G is composed of a series of vertices (nodes) and edges (ties). Visualizations are arranged in patterns based on a variety of algorithms that produce different layouts. Some algorithms allow for viewing a network in a hierarchical layout (like a traditional organization chart), some allow for nodes with high scores on certain metrics to be arranged in the center of the graph, and others control the attraction or repulsion of the nodes in the graph (Scott, 2000).

(2)   Descriptive measures

From a purely topological standpoint, networks are described in terms of density, centralization, fitness to common network models, boundaries of a network, and the

topology of a network. Additionally, each individual node can be described in further detail using a variety of metrics that describe the relative "importance" of a node in a network with respect to all other nodes. The metrics commonly focus on the position of the node within a network and are measured in different ways to determine how central a node may be. Each of these descriptions, adapted from Scott (2000), is discussed in further detail below.

Density is a normalized representation, from 0 to 1, of a network's interconnectedness (Scott, 2000; Everton, 2012). It equals the total number of ties that exist divided by the total possible number of ties. Networks are said to be dense if this calculation approaches 1 and sparse if the density is close to 0 (Scott, 2000). Density, however, is a poor measure when a network varies in size because the number of potential ties increases exponentially each time an actor is added to the network (Everton, 2012). This is a concern here because the size of the network increases over time. In such cases, average degree is used because it is not sensitive to network size (Scott, 2000; Everton, 2012).

Centralization describes the extent to which a network is concentrated around focal nodes in the network (Scott, 2000; Everton, 2012). While density describes the level of connectedness of an overall network, centralization focuses on how networks are organized around key nodes. When coupled with density, it can provide insight to the researcher on the structural properties of a network. Mathematically, centralization can be calculated on three levels: local, global, and betweenness. This measure, which ranges from 0 to 1, is the ratio of the actual sum of the differences of nodes to the maximum possible sum of differences (Scott, 2000). A network with a centralization of 0 is one where every node is connected to every other node. A network score with a centralization of 1 is where all nodes are connected to a single node (Scott, 2000). The standard measure of centralization is also limited because it compares actual scores to the highest score. A useful alternative (but not a substitute) is standard deviation, which compares actual scores to the average score (Everton, 2012).

While centralization and density describe the overall network, *centrality* focuses on individual nodes (Scott, 2000). Centrality can be measured in several ways, but the

primary means of measuring centrality are total degree, in-degree, out-degree, betweenness, eigenvector, and closeness centrality (Scott, 2000; Everton, 2012). Each of these calculates, by node, the degree to which a node is central depending on the measure used. Total degree centrality is a count of the number of ties each node has (Scott, 2000; Everton, 2012). In-degree only counts ties pointing toward a node, while out-degree only counts ties pointing away (Scott, 2000; Everton, 2012). Betweenness centrality calculates the degree to which a node lies on the shortest path between other nodes in a network (Scott, 2000; Everton, 2012). Eigenvector centrality calculates the centrality of a node based on its connections to other "important" nodes (Scott, 2000; Everton, 2012). Finally, closeness centrality measures how close, or proximate, a node is to all other nodes on the graph in terms of path distance (Scott, 2000).

While not a descriptive measure per se, *network boundaries* and definitions will affect the calculations and analysis of any network type. How a network is bounded and where one defines the borders of the network (what is considered "in" or "out") can affect how one describes a network in its physical terms. The researcher must clearly define the boundaries of a network when conducting an analysis and explain how he/she chose to bound the network of interest (Scott, 2000). For the semantic networks in this study, the boundaries of these networks were a result of the data set used. The text documents generated from the archival records limited the semantic network to the corpus of text files that were available to me.

Network topography describes the properties of a network in terms of structural layout and how well or poorly the network fits various archetypal models. These models, which include names such as small-worlds, scale-free, star, mesh, help researchers describe the visual and structural properties of a network (Scott, 2000).

APPENDIX B. PROJECT TIMELINE

This consolidated table includes events from non-email records that were crosschecked using email correspondence. It does not include every meeting or event during the entire reporting period, but does include the key events and actions of the project.

Date	Event	Type
2/1/2009	Initial concept for field communication platform	Concept
4/1/2009	HTACS FEX III test plan	White paper
6/15/2009	HTACS briefing	Brief
6/15/2009	SPAWAR Fellowship Proposal	Proposal
7/20/2009	Crimson Viper 09	Exercise
8/1/2009	SPAWAR Fellowship Submission	Proposal
8/1/2009	MIST brief	Brief
9/1/2009	MIST brief for Thai MRDC	Presentation
9/3/2009	NPS Research Alliance Coordination Trip	Trip
9/10/2009	Update brief to ODC Cambodia	Brief
9/11/2009	Research Alliance Out brief	Presentation
10/4/2009	Thesis modification	White paper
10/5/2009	iRAPIDS briefing to CAW	Brief
10/16/2009	Meeting with ONR	Brief
11/3/2009	NPS Research Alliance Coordination Trip	Trip
11/14/2009	Specification development	Technical
11/16/2009	FIST Test Concept for SE Asia	Proposal
11/19/2009	FIST vs Small Worlds vs TIGR Comparison	Technical
12/9/2009	FIST CORE Proposal (Military Geography)	Proposal
1/20/2010	Geo-mapping Conference with 95th CA BDE (1/20-1/21)	Presentation
2/7/2010	FIST proposal to CNTPO	Proposal
2/11/2010	Master brief template	Brief
2/22/2010	Briefing to USARPAC, USPACOM J-9	Presentation
2/24/2010	Briefing to MEC	Presentation
2/24/2010	Briefing to PACOM J5	Presentation
2/24/2010	Briefing to PACOM J4	Presentation
2/24/2010	Briefing to PACOM J51	Presentation
2/25/2010	Briefing to Hawaii Center of Excellence	Presentation

Date	Event	Type
2/25/2010	Briefing to Chaminade University	Presentation
2/25/2010	Briefing to Pacific Disaster Center	Presentation
2/28/2010	Briefing to ONR SCCM Conference	Presentation
3/2/2010	FIST brief built for USAID	Brief
3/3/2010	FIST brief built for SCCM	Brief
3/3/2010	SCCM Conference in Phuket, Thailand	Presentation
3/8/2010	FIST brief for CMO	Brief
3/12/2010	Motorola phone purchase request	Equipment
3/12/2010	Netbook purchase request	Equipment
3/20/2010	FIST brief built for University of Central Florida	Brief
3/25/2010	FIST brief built for U.S. Pacific Command	Brief
4/8/2010	FIST presentation for Pacific Endeavor	Presentation
4/9/2010	FIST Light concept paper	White paper
5/17/2010	Purchase request for triple monitors	Equipment
5/17/2010	Purchase request for Alienware	Equipment
5/17/2010	Brief built for USMC audience	Brief
5/19/2010	CARAT Thailand 2010	Exercise
6/8/2010	FIST information quad	Brief
6/11/2010	FIST brief for AFSOC	Brief
6/15/2010	FIST overview brief built for SOCPAC	Brief
7/15/2010	FIST thesis revision 6 document	White paper
7/23/2010	Funding proposal for FIST 2011	Proposal
7/28/2010	Purchase request for Apple Trackpad	Equipment
7/28/2010	Brief for USASOC	Brief
7/29/2010	FIST proposal for USASOC	Proposal
8/5/2010	FIST VTC brief	Brief
8/9/2010	FIST HSCB proposal to ONR	Proposal
8/12/2010	Market survey document	White paper
8/12/2010	Purchase request	Equipment
8/19/2010	Pacific Endeavor (8/19-8/27)	Exercise
8/19/2010	Engagements list from PE10	Brief
8/20/2010	FIST USAD brief (HA/DR)	Brief
8/27/2010	Accepted into PhD program	
8/29/2010	Afghanistan field trial (29 August through 5 November, 2010)	Field test
8/30/2010	FIST brief to PACOM J4	Brief
9/1/2010	VSP collection in Afghanistan	Collection
9/1/2010	Thesis published	Thesis

Date	Event	Type
9/5/2010	Gobi Wolf collection in Mongolia	Trip
9/20/2010	FIST brief (Master document)	Brief
9/23/2010	FIST brief for ACMC	Presentation
9/29/2010	MWCG brief	Brief
10/4/2010	FIST Homeland Security Consortium Quad	Proposal
10/20/2010	FIST brief CAHLS	Brief
10/25/2010	CAHLS Budget submission	Proposal
11/2/2010	FIST brief which includes Afghanistan examples	Brief
11/6/2010	FIST outbrief (Afghanistan) with examples	Brief
11/8/2010	FIST presentation to PhD seminar	Presentation
11/8/2010	FIST executive summary outbrief	Presentation
11/9/2010	Statement of Work–CHSC	Proposal
11/10/2010	Kick off meeting with SOCPAC for FIST RP	Meeting
11/28/2010	FIST presentation for USAID Manila	Presentation
12/8/2010	OpenFIST proposal for CHSC	Proposal
12/8/2010	OpenFIST budget (CORE Lab only)	Proposal
12/8/2010	Statement of Work–CHSC	Proposal
1/3/2011	OpenFIST white paper	White paper
1/4/2011	OpenFIST independent gov cost estimate	Proposal
1/5/2011	OpenFIST brief for MCIOC	Brief
1/19/2011	OpenFIST presentation to SOCOM-USASOC	Brief
1/20/2011	iPod Touch purchase request	Equipment
2/1/2011	Limited field test with HCA forces Cobra Gold 2011	Field test
2/3/2011	Project update for OpenFIST	White paper
2/3/2011	Zerion sole source request	Equipment
2/4/2011	Project update to Intel department	Presentation
3/1/2011	Data collection in Springfield, Massachusetts with MSP Special Projects Team for Operational support	Field test
4/1/2011	Participation in RELIEF 11–04	Exercise
4/1/2011	Data collection in Herat, Afghanistan with SOTF-W for Operational support	Field test
6/1/2011	Lighthouse–MEC Collaboration	White paper
8/1/2011	Data collection in Khon Kaen, Thailand with III MEF, MEC for Exercise planning; operational support	Field test
8/5/2011	Lighthouse SOTF evaluation slides	Presentation
8/11/2011	Data collection in Port-au-Prince, Haiti with Rutgers University for Research support	Field test
8/16/2011	Lighthouse brief Afghanistan	Brief
8/17/2011	CORE methods training	Training

Date	Event	Type
9/1/2011	JSOU Essay on Redefining Intelligence Support	White paper
9/1/2011	Data collection in Guatemala with 11th Marines for Operational support	Field test
9/1/2011	Data collection in Philippines with MARFORPAC Medical Planner for Operational support	Field test
9/1/2011	Data collection in Quantico, Virginia, with SCETC for Training support	Field test
9/1/2011	Data collection in Ecuador with 11th Marines for Operational support	Field test
10/5/2011	MARCIMS Kickoff Meeting	
10/11/2011	Data collection in Salinas, California, with Monterey County Gang Task Force for Operational support	Field test
10/23/2011	Lighthouse training aid for Android	Brief
10/27/2011	Lighthouse brief–CORE Lab	Brief
11/2/2011	Lighthouse CHSC status update	Presentation
11/7/2011	Data collection training and education to III MEF	Training
12/5/2011	Lighthouse update brief–CORE	Brief
12/10/2011	CORE–Lighthouse MTT training (Feb 2012)	Brief
12/15/2011	Lighthouse CHSC status update	Presentation
12/19/2011	Lighthouse/CORE training course	Training
3/6/2012	MARCIMS IPR	IPR
4/1/2012	ONR Code 30 Technical Review MARCIMS	Meeting
2/1/2012	Cobra Gold 12	Field test
3/1/2012	Balikitan 12	Field test
10/1/2013	MARCIMS PoR established	Programmatic

APPENDIX C. PARTICIPATING ORGANIZATIONS

Table 47.   Organizations included in the study

Organizations	
11th Marine Regiment	Marine Corps Tactics Operations Group
1st Special Forces Group	Marine Corps University
1st Special Warfare Training Group	Massachusetts State Police
2d Radio Battalion	Milcord
7th Special Forces Group	Millennium KI
AeroVironment	MITRE
AF Behavioral Science	MyStuff
Afghan Counter Improvised Explosive Device	National Defense University
Afghanistan Pakistan Hands	National Geospatial Intelligence Agency
Arizona State University	National Security Agency
Army Geospatial Center	Naval Postgraduate School
ASRC-ARTS	Naval Special Operations Command
AT-Solutions	Naval Special Warfare Command
BAE	Naval Surface Warfare Center–Dahlgren
Big Kahuna Technology	Navy Facilities Command
Blue Spider	Northrop Grumman
Booz Allen Hamilton	Norway Naval Special Operations Command
C4i	NPS Foundation
California Homeland Security Consortium	Office of Naval Research
Canadian Defense Research	Office of the Secretary of Defense
Carnegie Mellon University	Pacific Command
CBS Broadcast Company	Pacific Fleet
CGI Federal	Palantir
Combatting Terrorism Technical Support Office	Potomac Institute
Combined Forces Special Operations Command Central Afghanistan	Regional Command Southwest
Combined Joint Interagency Task Force–Shafafiyat	RGS
Data Buoy	Root Change
Defense Intelligence	Rutgers University

Agency	
Department of Homeland Security	SAIC
Department of State	Salinas Police
Development Seed	Salinas Police Department
Drexel University	SCRA
DSCI	SDG Systems
Earthpoint	Seaside Police
ESRI	Silos
Ethnocorder	Soledad Police
European Command	SPAWAR Systems Center San Diego
Future of Networks	Special Operations Command
GDE	Special Operations Command Central
GeoIQ	Special Operations Command Pacific
Georgia Tech	Special Operations Command South
Global Relief Technologies	Special Operations Reconnaissance Surveillance Element
Google	Special Operations Task Force–Southeast
Greenfield Police	Special Operations Task Force–West
Headquarters Department of the Army	Special Warfare Training Group
Headquarters United States Marine Corps	SSU
Human Terrain System	Swan Island Networks
III Marine Expeditionary Force	Swedish Defense
ISS	Swedish National Defense College
John F. Kennedy Special Warfare Center	Tecolote
Joint Chiefs of Staff	Transportation Security Administration
Joint Chiefs of Staff–J3	TriggerFinger Software
Joint IED Defeat Organization	United States Africa Command
Joint Intelligence Operations Center	United States Military Academy
Joint Special Operations Task Force Philippines	University of Central Florida
Joint Special Operations University	US Agency for International Development
KBI	US Army Engineering Research Development Center
Kestrel technology group	US Army Pacific
Khronos	US Army Research Development Engineering Command

LGS Bell Labs	US Army Special Operations Command
Lockheed Martin	US Army Training and Doctrine Command
Los Alamos National Labs	US Central Command
MAGTF Staff Training Program	US Marine Corps
MARFORPAC Experimentation Center	US Marine Corps Capabilities Development & Integration
Marine Corps Civil Military Operations School	US Marine Corps Civil Affairs
Marine Corps Command Development Command	US Southern Command
Marine Corps Information Operations Center	Western Data
Marine Corps Intelligence Activity	Zenprise
Marine Corps Special Operations Command	Zerion

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APPENDIX D. NEWMAN GROUP TABLES

Table 48.   Newman Group–Period 4

Time period	4
Newman Modularity Score	0.711

Group	Size	Members
1	123	actor, advanced, allow_for, analysts, anthropological, applications, appropriately, artifact, assembly, backbone, basing, bi-directional, bidirectional, borrowing, caste, census, charity, cidne, cinde, clearly, client, collected, collection, conducted, constructs, context, countrymen, customizeable, data, database, defined, definitions, depicted, descriptors, dispersed, dowry, dynamic, dynamically, effects, efficient, enable, enables, entry, evaluated, event, exists, external, extra-regional, facilitate, feedback, fellow, flexibility, flexible, flow, flows, focuses, followon, form, formats, fusion, generalized, generic, global, goods, greater, incoming, incorporate, incorporation, integrations, integrative, intermarriage, intermediary, iphone, isvg, latest, links, medical, merit, methodology, mitigate, mode, operator, organization, prestige, processes, pull, pushed, rank, real-time, realizing, relationship, remote, requires, requisite, respect, robust, sa, sections, serve, server, socio-cultural, sources, standardized, static, stations, streaming, streams, structure, structuring, surrounding, survey, systems, task, tithe, toc, transactions, transfer, transformed, treatment, tree, tribute, understand,
2	93	3d, 4th, action, actions, activity, actors, acute, aid, analogous, applicable, assess, assessment, atrap, behaviors, benefactors, broadly, characteristics, construction, countries, crisis, customs, defeat, democracy, denying, development, diplomacy, disaster, disasters, distribution, enforcement, entity, established, globaly, granular, haven, health, hierarchies, hostile, humanitarian, impair, inspection, insurgents, interact, interaction, interoperability, local, localized, maintaining, man-made, managing, minimum, mission, missions, monitoring, natural, navigation, objectives, observe, operation, played_out, populace, popular, precursor, preparedness, proaction, proactive, proactively, program, programmatic, providing, provision, record, response, risk, scope, seamless, simplify, sites, smartly, southeast, sphere, stability, standing, storage, strategic, strategy, strengthen, tcaf, times, understanding, upload, village, warehouse
3	62	accomplished, attempt, attitudes, attribute, beliefs, category, certified, collecting, concept, conceptual, concurrent, configurable, conop, costing, culminate, customizable, definition, deliverable, deliverables, deployment, design, develop, developed, developments, ditscap, draft, execution, exercise, focused, fool, fully, guidelines, handheld, highly, implement, information_technology, internationally, learned, lessons, outlining, phase, phases, portion, preliminary, project, proof, recommended, representative, simple, sna, specification, staging, steps, subsequent, targeted, testable, tested, thesis, tightly, transparent, validate,
4	59	according_to, alarms, alerts, ao, application, applied, arcgis, asia, australia, binr, block, bureau, cameras, cases, college, communicating, console, custom, designs, detection, dhurakit, diagram, displays, dpuic, driven, embedded, focus_on, fused, geospatial, gis, goals, gracefully, grid, guided, images, instruments, intelligence, international, intrusion, iphones, map, native, naval, networking, pajek, panels, procedures, pundit, pushing, research-global, reside, seeking, side, temporal, touching, transition, ucinet, unique, visualization
5	53	ability, affairs, aggregation, allows, aspect, assessments, assimilation, backhaul, city, concepts, conclude, conduct, configuration, configured, conjunction, constructed, description, descriptive, displayed, extensions, geography, gina, iaw, identified, ims, in-country, in-depth, in_order, infrastructure, internal, irapids, leveraged, local_police, maintainability, managed, module, moe, mop, multi-level, nation, nature, objects, optimized, purpose, q2r, qualitative, quantitative, secure, straightforward, subset, technical, usability, utilize
6	46	adaptable, addition, additionally, adjust, alarm, algorithm, alliance, analyze, apply, assimilated, balikatan, capability, cobra, comprehensive, counterinsurgencies, developing, dissimenate, exercises, expand, export, feed, hardware, hearts, implementing, incorporating, indigenous, interview, inverse, involve, knowledge, leverage, management, minds, pacific, practices, process, products, provide_for, regional, routines, seek, smaller, tags, theater, toc-to-field, winning
7	40	actionable, age, airport, alarmed, amount, arts, behavioral, clinic, cultural, education, enacted, fast, fuel, handwriting, harbors, historical, hospital, individual, language, military_personnel, monuments, norms, occupation, packs, photographed, police, police_station, policies, ports, railroad, relative, religious, responses, roads, security_forces, sewage, sex, source, spoken, store
8	31	armed, attending, civilian, close, confinement, coordination, corp, corps, e-intelligence, employ, engagement, engineers, establishing, facility, focus, gater, government, ike, institutions, modules, mrdc, research_and_development, researchers, returning, royal, rtarf, spearheaded, tenure, thai, toolset,
9	29	acting, alert, amercian, analyzing, bangkok, bangladesh, clients, concern, dhaka, discreet, distributed, easily, embassy, fob, gathering, guide, hands, hn, interagency, jusmagthai, members, ngo, partners, personnel, psyop, residing, select, sof, tdy
10	25	availability, bangledesh, cellular, central, communications, conceived, connectivity, conventional, equipment, fy10, hybridized, initially, installed, late, lost, modeling, network, networks, phones, public, q2, q3, reason, resumed, wireless

Table 49. Newman Group–Period 5 (1–4)

Time period	5	
Newman Modularity Score	0.594	

Group	Size	Members
1	244	3gs, account_for, achieving, acquisition, actionable, advanced, advantage, aggregation, alarming, alarms, alerts, allow_for, analyst, analysts, analyze, answers, anthropological, ao, apple, appropriate, appropriately, arduous, assess, attribute, augmented, auto-correlation, automate, automated, automatically, automating, automation, behave, bi-directional, bidirectional, capability, cases, change, chosen, classifications, client, cmm, collect, collected, collection, collector, collectors, collects, combined, conceptual, conducted, consist_of, counter-narco, counternarcotics, cpu, crucial, data, dataset, decisions, depending, depicted, differing, disable, discussion, disparate, displayed, displays, edr, effective, efficient, efforts1213initial, enable, enhance, enhanced, entry, equally, ergonomics, evacuation, exchange, expansion, experience, exploring, extra-regional, facilitate, fast, features, feedback, felt, flexible, flow, flowing, fly, focuses, fonts, for_real, format, fuller, functions, fused, generalized, geo-statistical, geographical, geospatially, globaly, goals, graphic, handheld, hands, headquarters, images, impenetrable, imported, improved, in_relation_to, incoming, incorporation, increase, increasing, inexpensive, influx, informed, inserts, insurgency, interactive, internally, interoperable, interoperation, interview, intuitive, inverse, iphone, lags, limit, load, loads, localities, locally, manage, mapping7, maze, method, methodology, minimize, mist, mode, modeling, multifunctional, non-programmatic, notebook, objectives, occur, on_the_other_hand, operational, operator, operator-training, panels, populates, port, preferred, preparation, procedures, process, processes, procurement, prototyped, prototyping, providing, pushing, rate, readable, real-time, reboot, reduce, reduces, region-specific, relational, relationship, remains, remote, reordered, reported, reporting, request, respect, respondents, restart, restricting, result, returned, sa, satisfaction, save, scope, scoped, secure, seemingly, set, sets, side-by-side, signals, simultaneously, socially, sociocultural, sos, spatial, standardized, standards-based, store, stored, strain, stream, streaming, stress, structures, structuring, system_components, take_advantage_of, take_to, task, tasking, technological, temporally, terror, toc, toc-based, touch-screen, trained, training, transformed, transmission, transmittal, transport, triggers, typical, ubiquitous, unique, units, useable, utilizes, variable, visualizations, warnings, weather, wipe, worldwide
2	123	academia, academic, accurately, active, actors, adopt, alarmed, alter, analysis1617identifying, analytic, assets, backbone, backgrounds, bangladesh, behavior, bridge, capital, cell, choice, city, clusters, collecting, color, commercial, composition, comprehensive, computer, conceived, connection, covers, dang, dealers, decision-making, demoed, density, depict, desired, detect, disciplines, diversity, drawn, economic, encounters, encouraging, evolved, excluding, expected, fighter, forecast, gain, geospatial, growth, handful, handhelds, humanimmediate, hybridized, identifies, imaginary, impact, increased, inform, initially, installation, interact, kind_of, laptops, leads, lessen, link, lives, loss, maintenance, minus, narcotraffickers, network, niprnet, non-secure, papers, physical, population, positioned, predominant, premise, programming, properties, protocol, redraw, required, resentment, responses, restrict, resume, roles, router, seams, set_to, sharing, singapore, size, slides, socio-economic, sstr, staged, statistics, structure, subjects, supported, sustainable, targeted, temporal, terrain, together_with, topography, touch, train, uci, understand, understanding, uniquely, upgrades, visualize, vpn
3	121	10knowledge, additionally, addresses, adjusted, adopting, aid, alarm, algorithm, allows, amount, appliance, architecture, aspect, assimilated, at_rest, backend, by-product, central, centralized, certified, changi, component, components, console, context, cop, curfew, database, databasesinformation, dissemination, distinguishing, distribution, ditscap, dynamically, effectively, enables, enabling, enforced, everett, export, exportintegration, fields, flexibility, flows, fob, fusion, generation, geo-tagged, gina, handled, handles, in-real, incorporated, integrating, integrationanalytic, interoperability, iphone-based, irapids, knowledge, machine, managed, management, managementrobust, manages, managing, maps, metadata-centric, multi-level, native, natively, nga, offered, offers, pattern, picture, populate, potentials, practices, predict, prompts, provide_for, reconstruction, referred, regional, relies, replicated, report, represented, robust, sagip, samong, seamless, securely, semantic, sensor, series, server, service, shareable, smartly, sound, stacker, stand-alone, structured, tabular, tags, tailored, tie-in, time1415pattern, tlm, toc-to-field, transit, unclassified, underpinned, violent, visualization, visualizationdata, visualized, web, well-rounded, wrapper
4	117	according_to, analysts_notebook, applies, armed, assemble, assigning, barricades, began, behavioral, binr, broaden, bureau, capabilities11fist, capacity, capacity1314reports, centernaval, checkpoints, civil-military, convenient, customized, dashboards, deepen, dependent, describing, designed, designs, developing, disaster, ei, emplaced, enemies, engineer, entire, entries, ethnographic, example, executive, extra, focusing, forcing, generated, gis, guard, guided, handle, health_care, humanitarian, improving, incorporating, individuals, instructed, intelligence, interrelated, intimidating, leaders, managementpacific, manned, maximum, members, military_operations, nation, of_course, om, one_hand, operated, ops, overlayed, paperwork, partial, partnership, patrol, patrols, perceived, personnel, platoons, pm, police, postgraduate, predictive, products, proved, recruit, relative, remainder, reports, residents, responsibility, routes, royal, safety, scalable, school19summary, security_forces, select, served, side, sifting, sit, solve, source, squad, streets, strikes, submit, tag, thai, thailand, thoroughfares, traffic, transfer, trouble, usage4handheld, utilize, vbieds, village, vital, well-meaning

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Table 50.   Newman Group–Period 5 (5–10)

5	116	28civil, 477-9564219tactical, 4fist, ability, activity, affairs, android, application, applications, approved, arcgis, assessment, assessmentincludes, assessments, authors, basically, bg, block, bridges, build, buildings, clearly, complete, conducting, configuration, conflict, contained, crisis, customer, customizable, damage, define, definition, denying, described, detail, developed, development, diagram, dictates, disasters, discussed, dynamic, earth, ease, embedded, end-to-end, essentially, experiences, exported, expose, familiarity, focused, framework, fully, gained, gater, geography, granular, greater, guidelines, heavily, hostile, ike, in-country, incorporates, infrastructure, inspection, integrations, interagency, kit, latest, learning, leverage, limitless, map, modified, module, modules, pajek, php, planning, plug-ins, popular, possibilities, preparedness, program, public, questionnaire, reachback, record, replaces, represent, requirements6, roads, running, seamlessly, shapefile, spending, stability, strategies, supplement, survey, tcapf, teams, tested, tests, thoroughly, toolset, transition, ucinet, updating, used_to, viewed, visualizing, vlado
6	93	1-mode, 2-mode, actions, audio, availability, average, bluetooth, bus, capable, cellular, chemistry, citation, collaboration, color-coded, communication, communications, concern, configure, connectivity, conventional, customization, data-mining, description, designing, diffusion, dispersed, enterprise, equipment, genealogies, global, gsm, hn, hotspot, imagery, indigenous, infantry, innovations, instantly, interaction, internet, interoperabilityfist, irretrievably, language, large, links, local, local-storage-and-upload-on-resumed-network, lost, maintaining, markup, molecule, multiple, netml, networking, networks, ngo, on-the-fly, operate_on, outdated, packs, percentage, phones, practical, programmable, protein-receptor, pub, pushed, re-stack, real-time-data-interaction, reason, recognition, recording, regained, securitymulti-national, serial, sgml-based, si, simplify, slovenian, spider, storage, supports, transferred, transmitted, universal, unmarked, usb, usb5module, voice, wi-fi, wireless, wlan, word
7	87	accomplished, addition, aforementioned, assessing, auxiliary, award, backhaul, backhauls, backup, bangladesh, battle, beds, begun, cells, clinics, comprise, concurrent, conditional, conduct, conops, consultation, contract, contributions, conus, cooperation, correct, deficiencies, deliverable, demonstration, deployment, detailed, develop, developments, effortsreliable, encrypted, envisioned, evaluation, execute, external, failure, feature, finalize, functionality, gas, government, graphical, hardware, hospitals, iboc, in-depth, integrated, leavenworth, measuring, metrics, mosques, nuanced, outlined, overlays, package, partners, patients, phase, phases, pico, portions, pre, produce, prototype, ready, recovery, refine, reliable, retest, satellite, scenario, schools, shipment, shipping, specifications, stage, stations, superior, supplier, technical, testable, update, usg
8	75	alliance, allowing, anticipated, broken, calculated, centrality, characteristics, concept, conop, consideration, costing, culminate, deliverables, demonstrate, design, determining, draft, effectiveness, elementary, enclosing, endeavor, estimates, execution, exercise, finally, focus, focus_on, fool, four-part, graph, identification, identifying, implement, intent, largest, learned, lessons, libraries, measures, moe, moes, months, mop, mops, needsdevelopment, operationally, outlining, pacific, performance, portion, preliminary, progresses, project, proof, purpose, purposes, realistic, recommended, representative, role, simple, special_operations, sponsorship, staging, standards, steps, subgroup, thesis, transparent, understood, unified, validate, validated, validation, x-graph
9	71	action, agencies, algorithmic, analytical, analyzed, antiquated, augment, basing, broader, carried, centers, cidne, commercially, complement, complements, connects, core, counterparts, countries, cradas, databases, environments, existing, experts, feed, fid, fielded, fits, foreign, individual, interchange, interfere, internal, interpreted, isvg, iterations, lab, larger, mission, mitigated, models, operate, operators, partnerships, pictures, platforms, plurality, populating, previous, pulled, reconnaissance, replace, replacement, scale, shortfall, sit_down_with, slide, sna, sources, special, sr, stove-piped, strategic, subject_matter, subsystems, systems, unconventional, usasocs, uw, variety, wcid
10	47	age, altered, aor, appear, artifacts, associative, attributes, boundaries, complimentary, connections, cross, cultural, daily, depicting, education, effects, elements, engaging, exploit, fighting, forced, indicate, influence, intertribal, kinship, living, mayor, mitigate, myriad, neighborhood, occupation, occupational, organizations, rarely, regions, relationships, religious, respondent, sex, sheiks, sociograms, stalls, sympathies, threat-counterthreat, trends, tribal, unusual

Table 51. Newman Group–Period 6

| Time period | 6 |
| Newman Modularity Score | 0.688 |

Group	Size	Members
1	95	advances, aggregation, alerts, allows, analyst, analytic, analyze, android, appropriate, audio, automated, automatically, automating, backend, browser, coding, collect, collected, collection, comm, conducting, custom, customization, data, decision-aids, deployable, designed, disparate, enable, enables, entry, expanded, export, exported, find_out, focusing, fusion, fusionportal, fusionview, geo-mapped, geocoordinates, geographic, geostatistical, ideally, imagery, imported, incorporate, increase, internet, iphone, know_how, knowledge, linked, linux, log, management, manipulation, master, morphed, multi-format, offers, portal, processed, providing, pushing, real-time, real-world, reducing, reliability, remote, reports, robust, ruggedized, sensor, sensors, sequenced, sharing, smartphone, sociocultural, streamlining, structured, systems, training, turnaround, unclass, unstructured, user-friendly, utilizes, validity, view, visualization, visualization, web, workload, yesterday
2	60	academe, action, actors, addition, affairs, agency, assessments, bangladesh, bangledesh, capital, cidne, close, cn, coin, coordination, core, counter-narcotic, counterinsurgency, customer, demoed, disaster, disasters, dynamic, enabling, enforcement, exchange, existing, fid, foreign, geography, guide, ha, humanitarian, identified, identifying, in-country, infrastructure, inspection, installation, internal, missions, modeling, natural, network, popular, preparedness, proactively, reconnaissance, response, sna, source, special, sr, staged, teams, timeframes, unconventional, united_states, uw, vpn
3	42	accomplishment, advancement, advancements, apan-fist, assessment, breakdown, capturing, categories, communications, conducted, conflict, effectiveness, enhance, environments, example, exercise, exercises, framework, harnesses, health, heath, influence, latest, media-rich, mission, myriad, negatively, overstated, planning, positively, report, risk, sets, socio-economic, socpacs, supports, tcapf, technological, tempo, terrain, variety, web-based
4	39	activity, aid, concepts, confirmation, cop, denying, development, distribution, employment, engagement, facilitate, flow, fpc, functions, hostile, improvements, injects, map, networks, opera, operation, organizations, partners, pe10, phases, procedures, real, reconstruction, release, reliable, scenario, shape, stability, subsequent, tactics, techniques, ttps, viewable, visualization
5	33	assess, associated, biometric, capability, composition, continues, determining, disposition, dissemination, dissemination, dynamics, gain, gap, insights, interact, involves, lacks, makers, momentum, nuisances, picture, population, powerful, remain, requirement, requirements, scd, select, social-cultural-dynamics, socio-cultural, strength, todays, unique
6	27	analytical, calculated, cellular, conceived, consideration, consist_of, demonstration, deployment, develop, evaluation, focused, identification, initially, integrating, iphones, leads, learned, lessons, months, operate, operational, phase, project, prototype, ready, technical, timeline
7	23	configuration, configurations, database, effective, evaluate, gui, hardware, international, investigation, isvg, optimize, package, portion, prioritize, program, specification, staging, studies, tested, validate, violent, wcid, worldwide
8	18	alarmed, broad, disconnected, displayed, fill_out, flexible, focus, form, fused, individually, irb, landscape, logically, macro, national, strategic, trend, understanding
9	17	3d, asset, bubbles, collects, comprehensive, describing, developing, ei, enemies, ethnographic, icons, images, intelligence, maps, members, popup, recruit
10	16	afghanistan, central_command, combined, counter, counterterrorism, cp, csocc, force, mass_destruction, proliferation, psychological, psyop, sfa, special_operations, sponsorship, weapons

Table 52. Newman Group–Period 7 (1–4)

Time period	7
Newman Modularity Score	0.651

Group	Size	Members
1	225	1-mode, 2-mode, abass, abassi, ability, adds, advanced, afp, al, alert, alerts, all-source, amount, analysiss, analyst, analytic, analytical, android, andtwoofficersfrom, apparatus, apply, arceditor, archival, archived, arcview, assessing, assessments, audio, automate, automating, autosuggestions, awaiting, backend, backup, borgatti, brainpower, briefedtheafpj-6, by-product, cache, capturing, cartography, cell, championed, choice, colgaledo, collected, collection, collector, collect, combined, commercial-off, commercial-off-the-shelf, commonly, computer, computers, conduct, conducted, configure, connected, consists, consolidates, customized, data, decision-aids, departure, describing, designing, device-management, devices, dilemmas, dissemination, easily, effort, ei, enables, energy, engagements, ethnographic, existing, expanded, exploitation, exploiting, export, exporting, extensive, field-based, field-tests, fields, finds, flow, focus_on, focusing, foremost, form-based, formats, functionality, fusionview, gathering, geospatially, globe, guided, handhelds, handles, harness, high-end, imagery, importation, importing, improved, incorporate, inflexible, intelligence, intelligent, interchange, interfaces, ipr, j-2, kind_of, knowledge, labs, laptops, lift, lightweight, limit, locally, management, manipulate, manipulation, marwan, mayor, media-rich, merging, methodologies, migrate, minimize, minimum, modeling, morphed, multimedia, myriad, no_more, objects, on_hand, operate_on, operator-training, oriented, outputs, overlay, pdas, pe, pe10, phones, phones, photographs, plurality, portable, processed, prompts, proved, providing, purchased, rachmani, ready, real-time, recoding, reduce, relational, reliable, rely_on, replication, reports, report, geo-coordinates, repository, richer, robust, routers, scenario, senior, series, serving, set, sets, sharing, sheik, simplify, sites, smart-phone, smart-phones, smartphones, socially, soil, soldier, sources, spatial, stacking, standardized, step_in, storage, stored, storing, structured, structuring, submissions, submittedover50unique, technical, temporally, tests, the-shelf, time-consuming, toolset, transmittal, transposing, typical, unable, uploading, useable, user-friendly, variety, viewers, villages, visualization, voice, volumes, warfighter, web-based
2	163	40-sorr-j8-r, 9-line, accepts, accomplishment, addresses, aggregate, analyze, android-based, antiquated, app, application, approved, architecture, arduous, at_hand, auto-morphic, automated, automation, backed-up, broader, builds, capability, carnegie, casos, centralized, classifications, cliques, codified, collate, collect, commercially, component, components, composed, comprise, configuration, connectivity, consist_of, content, cpu, create, creation, daily, database, databasing, decision-making, deploying, description, detailed, determining, disconnected, displays, distract, downloading, dsn, edit, eliminates, empirical, employed, enable, enabled, entirely, equipment, equivalence, estimating, exist, facilitate, facilitating, factions, factor, failed, feedback, figure, flexibility, footprint, form, four-part, free, gap, geo-referenced, hands, in_order, insights, institutionalized, instructions, internet, lacks, lags, laptop, logging, main, makers, manage, manages, measures, mellon, minimally, minimizes, mission, natively, new_to, odk, official, open_source, operates, operator, optimized, organizational, overstated, parsing, passes, pattern, previous, process, procurement, protocol, prototyping, questionnaire, rationale, recognition, reduces, regular, released, replaces, replacing, repositories, requires, resides, residing, router, routines, running, scale, semantic, sensitive, shortfall, simple, siprnet, sorr-j8-r, spare, staffed, staffing, stove-piped, streamlined, structural, submission, supplies, survey, systems, topography, trained, transmit, ubiquitous, unclassified, unique, unstructured, utilizes, validation, vendor, widespread, work_in, worldwide, xforms
3	142	240v, 81m, account, achieving, additionally, administration, adopt, advances, alarms, algorithmic, allows, alternative, answering, balikitan, biostate, briefedjustinsherman, capable, carat, clicking, closely, college, combination, commercial, connection, consortium, construct, convenient, corps, costs, cycle, demographics, deployable, disparate, dispersed, distance, distribution, domestic, effectively, endeavor, enterprise, exercise, formalized, fractions, functions, fusion, fusionportal, globaly, gobi, googles, gots, hardware, health, homeland, hyperlink, implemented, implementing, indonesia, intact, integrate, interaction, interfacing, intrusion, kansas, kestrel, ktg, leavenworth, literature, machine, managed, marine, match, methods, mongolia, monitoring, multifunctional, off-the-shelf, offered, offers, open-source, organizations, owned, pacific, partnership, party, pending, philippines, populate, popup, portability, portal, practical, presently, proof, provision, pull_in, regional, regionaladvisorforeast-asia, remains, remote, robin, rp, ruggedized, saber, sage, scoped, seacat, secure, sensor, sensors, server, setup, singapore, spares, special_operations, specifications, standalone, start-up, statistical, subsystems, supports, surveillanceâ€information, talismen, task_force, thailand, toc, toolkit, transferred, transferring, transitioned, ungoverned, unmanned, usd, vehicles, verification, view, viewer, visualize, waiting, web, window, wolf, workstation
4	122	180a, 18a, 18f, 37a, 37b, 38a, 38b, actors, agencies-usaid, analyzing, architected, assets, assigned, awards, benefit, capital, casual, categorization, civilian, collecting, consolidating, contract, crucial, cultural, defiance, defined, degrees, delivering, demonstrated, develop, divided, doctrine, dotmlpf, downtime, education, effective, employ, equivalent, excellent, exists, experiences, facilities, fahrenheit, fenced, fixed, freeware, fully, functioning, government, handheld, ideally, in-house, infrastructure, integrations, intermarriage, intimidating, isaf, liscensing, listed, logical, lucrative, maintaining, manning, map, method, mining, narcotrafficking, non-material, ongoing, opportunity, organization, packaging, personnel, physical, population-centric, potentials, programming, programs, proximity, purchase, radars, rank, recipients, refresher, regiment, reliably, removing, requesting, required, research_and_development, reside, role, sea, sig, smaller, socio, solve, sponsor, sponsors, sponsorship, ssd, standards, stated, structure, subtopics, sufficient, suited, swcs, synergistic, system_components, tables, terrain, tied, timeline, total_number, training, uptime, usg, usmil, ussof, versus, visualizing

Table 53. Newman Group–Period 7 (5–10)

5	120	abdul, accurately, actor, aka, analyzed, assessment, avoidance, avoidance, back_and_forth, calculated, calculating, casting, centrality, change, characteristics, charity, cidne, clustering, clusters, comisaf, communication, compact, conducting, conflict, conop, contracting, counter-threat, created, defiance, density, designed, detection, deterrence, direction, distill, dividing, dowry, dynamic, edited, ego, engineers, ensuring, entrepreneurship, esp, examined, exchange, exported, fists, flexible, framework, geo-spatial, geo-statistical, geospatial, grouping, hajji, handbook, incidents, innovation, integrative, investigations, juma, jumas, kaf, kharim, link, loaded, loading, louise, malik, mapped, marginalizing, mcioc, merit, meta-network, metrics, mohammad, nepal, network, occupants, omar, operate, outbonp, outdeg, period, planning, players, procedures, public, razaq, raziq, relationship, representation, respect, scores, sector, shafe, smartphone, sna, steps, style, submit, surveysid, sustained, tactics, tcapf, techniques, temporal, threat, tithe, trail, transfer, transitivity, tributary, troubleshooting, ttps, uniting, usage, vulnerabilities, wali, yunis
6	114	6-month, agreement, allowing, apparent, argues, attribute-only, attributes, audiences, backhaul, balance, budgeted, capacity, cellular, cerp, city, co-operative, comparing, complement, conceived, continuation, contrasting, crada, deliverables, depicted, deployment, development, effects, enduring, engage, entity, evaluated, expended, fist-hscb, fist-thailand, focused, forecasting, freedom, frequency, fy11, generated, gigabytes, grass_roots, grievances, handle, identified, identities, impacting, improvements, independently, individual, individuals, initially, integrating, international, io, irregular, isvg, kai, koa, kpps, late, leverage, leveraging, lines, local, long_term, macro-level, majority, merchants, mitigated, moved, multi-level, multi-mode, multi-plex, negatively, networks, open-data-kit, operation, operationally, overwhelming, paper, parameters, peoples, perception, performance, products, project, proposed, providedbriefstotheusembassylawenforcement, qtr2, qtr3, qualified, radio, relationships, represent, reproduced, responses, rf, rso, satellite, security_forces, selecting, social_welfare, society, studies, subject_to, submitting, supported, tested, traditional, uniquely, user-defined, violent, wcid
7	100	acquisition, afghanistan, analysts, appears, applications, appropriately, arcgis, arcinfo, asymmetrical, attendance, augment, august-october, availability, bali, batagelj, briefedcdrgregst, chief_executive_officer, combat, completion, complimentary, comprehensive, comps, continue, core, counter-gang, coursework, datasets, dcgs-a, desired, distributed, diversity, earth, embassy, enhance, enhanced, established, evaluation, examine, exceptions, exclusively, executive, expected, extremely, focuses, forced, format, generation, goal, graphical, growth, gui, handling, headquarters, highlights, illuminating, in_turn, insecurity, instrumental, interoperability, interviewed, jusmagphil, kit, lab, large, lighthouse, maintenance, methodology, mrvar, navyprograms, operational, ora, overlays, package, pajek, performer, picture, pierre, pilot, positive, powerful, practically, program, rate, reception, record, refute, replace, requisite, screen, shot, source, speaking, summary, system-army, tandem, todays, ucinet, ultimate, used_to, ways
8	92	acting, adirah, affiliations, age, agencies, alikozai, alizai, alm, alp, analyses, ansf, arghandab, artificial, assisting, attempting, bazaar, behavioral, bolster, brokers, candidates, caution, centers, cohesive, concepts, cong, connections, controls, destabilizing, district, elder, elements, employment, empower, enforcement, example, executed, farmers, geo-location, geographic, giroa, governments, guide, identification, in_charge, increase, indigenous, interdicting, kakar, kandahar, karzai, khakrez, kinship, labor, landowners, maliks, mechanism, nagahan, naquebullas, northern, nurzai, occupation, performing, popalzai, prc, predictive, promising, qaeda, rebuild, recruitment, refined, represents, requiring, scientists, sex, shape, share, solely, solidarity, spectrum, strategic, structures, subgroups, sunni, taxationâ€, taxi, terror, theories, transition, tribal, uprising, vice, viet
9	88	action, agency, altitude, arguably, authentication, boxes, brother, cases, caste, categories, cdma, cloud, cloud-computing, controlled, cousin, creating, de_facto, differently, drives, entry, ethnic_group, excel, facility, failover, father, feet, fid, files, foreign, formatted, gender, generators, gis, global, gsm, hosting, improve, in_operation, incorporated, incorporating, inter, internal, intra, king, kits, lover, minutes, mother, multitude, nationality, objective-through, ocm, organizational, participated, pelican, permission, permissions, pmt, populated, powered, pre-configured, processes, processors, prolific, protected, pushes, ranking, reconnaissance, selections, service, set-up, sfqc, special, spreadsheet, sr, standard, subsets, symbol, taught, teacher, terabytes, text, tier, transit, transport, unconventional, uw, write
10	85	adequate, adirahs, appropriate, associated, behavior, browsers, cables, coercion, coincides, collaboration, collaborative, commanders, communities, compatibility, compatible, composition, computaitional, concept, conceptual, confirmed, consensus, considerations, databases, defines, detrimental, developed, developing, disposition, district-products, district, districtproducts, drivers, efficient, emerge, enabling, encouraging, enemies, engagement, exactly, exercises, external, extra, fist-specific, frameworks, fuse, fused, gain, identifying, increasing, influence, interact, interagency, intuitive, iw, joc, lecture, likely_to, lives, maneuver, maximum, members, months, multinational, normative, nuisances, partners, populating, population, populations, projects, rechargeable, recognizes, recruit, reporting, requirement, self-correct, socialization, sociocultural, strength, taliban-menaced, uncontrolled, understand, understanding, uspacom, vsp

Table 54.   Newman Group–Period 8 (1-4)

| Time period | 8 |
| Newman Modularity Score | 0.596 |

Group	Size	Members
1	307	3unclassified, aar, account_for, accredited, achieving, actionable, additionally, addresses, adjust, advanced, advantage, aggregation, aid, alarm, alarms, align, allow_for, allows, analyses, analytic, analyze, analyzed, analyzing, androids, appliance, approaches, appropriate, appropriately, architecture, architectures, arduous, artifact, assembly, assess, assessing, associate, at_rest, audio, augment, automap, automated, automating, backend, batafelj, behave, bi-directional, bias, bidirectional, binr, blood, bluetooth, breed, briefings, browser, bureau, button, capability, capacities, capacity, capturing, casual, cells, census, centralized, certified, classifications, client, codified, coding, collect, collected, collecting, collection, collector, collects, columns, combination, combined, commissioned, compilation, completeness, complex, complexity, component, condition, conducting, constant, constrained, constructs, content, context, count, creates, custom, customized, dam, data, decreasing, dependent, depending, describing, detailed, developing, disaster, discussion, disparate, dispersed, displayed, displays, dissemination, distance, distinguishing, ditscap, double-checking, downloaded, driven, drives, dynamic, dynamically, edr, effective, efficient, efficiently, effort, ei, enable, enables, engines, enhanced, enterprise, entry, environments, equally, ergonomics, eschelon, ethnographic, evaluating, event, example, exchange, exists, exploitation, exploration, export, exported, exporting, exports, external, facilitate, facilities, factor, fast, field-based, fields, finally, fingerprint, first-responders, flexibility, flexible, flow, flows, fluid, focuses, fonts, forgotten, form, fused, fusion, fusionportal, gather, gathering, generalized, generic, gina, gis, global, granularity, graphic, greater, handheld, handle, handled, hands, handwriting, haphazard, hardware, harvard, illiterate, images, improved, in-the-field, in_turn, incoming, incorporated, incorporates, incorporating, incorporation, informal, inputted, inquiries, institutionalized, integral, integrated, integrates, intelligence, interactive, interoperability, interoperable, interpretation, interview, intimidating, intuition, inverse, know_how, knowledge, lags, large_scale, larger, lat, legitimate, load, loaded, lower-level, machine, manage, management, manages, manually, maximum, media-rich, mental, mere, meta-network, method, modeling, modification, modified, months, more_than_enough, multidimensional, multifunctional, national, nations, natively, neck, networked, networking, new_to, newest, numbers, occur, occurring, on_the_other_hand, operator, ora, organized, oriented, overlooked, owner, packaging, parallel, password, pattern-searching, perform, performers, phones, photographed, photographs, point_to, pooled, portal, powerful, practices, preliminary, process, processes, procurement, promoting, properly, protected, prototyping, proved, provide_for, providing, publicly, pull, pull_out, purely, quantifiable, ranges, rate, re-analysis, re-ordered, readable, ready, real-time, reduces, referred, relationship, relies, remember, remote, report, reported, reporting,
2	294	150-man, 18f, 2nd, accepted, account, achieve, acting, actively, actor, actors, adirah, adirahs, adjusted, affiliations, affiliationusaid, afghan, age, aggregate, aggregated, agreed, alikozai, allowed, alp, ana, anp, answered, answers, approaching, army5, artificial, ask_for, associated, associates, assumption, assumptions, attendance, attended, attendees, attending, attribute, backbone, basics, bazaar, behavior, belonging, benefiting, benefitting, biased, blindingly, borgatti, bottom, brave, bringing, broadcast, broken, brothers, called, calls, capitalize_on, cbo, central, central_command, centrality, centrally, characterizing, choice, clicks, closely, closer, clusters, cockfights, color, colombian, columbian, combine, come_into, common_knowledge, communication, comparing, compete, compile, composed, conceal, concealed, conceived, concentrating, conform, conjunction, connected, connections, construction, consumption, continue, contracting, corroboration, crop, cryptologic, customary, customs, deference, define, deh, delineated, denoting, deny, depicting, depicts, deployed, descends, detachment, detrimental, dichotomize, dichotomized, direction, discussed, dissimilarity, dollars, done_with, drawn, drop_out, education, effectiveness, ego, elder, elders, elements, employment, enemies, engendered, engineer, entire, entirely, entities, equal, evening, eventually, executives, exist, expectations, expected, extraction, familial, family, fathers, favor, fledgling, floridas, for_example, forecast, fragments, gatherings, generally, geo-spatial, geographic, go_to, gracefully, graphically, hajji, half, handhelds, health_care, heavily, held, helped, hesitant, hierarchical, highest, highlights, homes, hybridized, identified, impacting, imposed, impressed, in_particular, inclusion, indicated, individual, influenced, initially, interviewing, interviews, involving, isolation, itwas, juma, jumas, jumasâ€™mohammad, kahaalah, kala, karez, khakrez, killing, kinship, kite, kite-flying, landowner, laptops, ldi, leading, leavenworth, lie, lights, limitations, linked, links, linksit, livelihood, local_police, locations, lowy, malik, maliks, manarah, manipulated, mapped, marginalized, marginalizing, meaning, measures, mechanism, members, merchants, metrics, mid-level, miso, mix, mode, modify, modifying, moe, mohammad, mohammed, moonlight, mop, mosque, movement, mullah, mullahs, nabi, nagahan, naquebullah, nazerulla, nazerullah, nearby, necessities, negatively, network, network2, networksless, night, northern, notice, nurzai, obvious, occupation, of_course, ofcomisafs, omar, opinions, oversight, owners, participants, participation, paths, patrol, performance, persons, platforms, players, popalzai, positive, postings, predict, premise, prioritize, private, procedure, promising, publically, rahmatullah, range, ratio, recruit, redraw, refining, refuting, regular, relating, relational, relationships, religious, represents
3	155	3gs, accomplished, accreditation, adoption, afghanistan, afghancontractors, agency, agree_with, airfield, analysts, answering, anthropologists, apple, applications, approval, approved, arabian, astounded, atrium, attempt, audience, august-november, august-october, broad, categories, certification, channels, chosen, chsc, coin, commanders, completely, computers, concept, concern, concurrent, conducted, conop, consensus, consideration, consist_of, contracted, counter, counterinsurgency, counterterrorism, courseware, definition, deliverable, demonstration, denying, deployment, design, details, development, developmental, developments, devices, diacap, disagree, distributed, divided, draw, ease, empowering, encompasses, ends, energ, envisioned, escape, execution, experimentation, feat, feedback, fidelity, fled, focus_on, fool, forced, format, gates, graph, graphical, haiti, historically, hostile, humanitarian, implement, inappropriate, indonesia, inexpensive, intentionally, interviewed, ios, ipad, iphone, ipod, isaf, kandahar, kit, korea, laptop, latest, learned, lessons, libraries, limit, main, manuals, marginalize, mexico, militars, milspec, mongolia, monoglia, netdraw, ngo, objective, officially, outlined, outlining, overlays, pacific, pashtun, pass_through, patrols, pending, peninsula, period, permutation-based, phase, phases, philippine, philippines, pilot, pm, portions, preferred, presenting, program, programs, proliferation, proof, proposal, providingservices, psychological, psyop, pulled, purposes, pushed, queries, ranging, record, relcalc, requested
4	146	1st, 3access, accessible, adequate, afghani, agent-based, agreement, allowing, amenable, ansf, applied, arghandab, assisting, at_the_same_time, atmospherics, attempting, audiences, basing, belongs, biowar, bits, bolster, broadcasting, caused, cidne, cinde, city-scale, clearly, closed, co-opt, coalition, collaborative, commentary, commonly, communicate, communities, compelling, composition, comprehensive, conceptual, concise, confirmed, constructed, contractors, cooperative, cooperatives, corrected, counter-terrorism, crada, create, database, defined, demands, denote, develop, developed, dimension, district, district-level, districtâ€™products, downstream, dynamic-network, emailed, employees, enabling, encouraging, engage, engagement, engaging, evolved, executing, extract, families, farmer, farmers, females, fertile, forward-deployed, frameworks, freely, fully, fusing, gain, gaining, giroa, glance, gleaned, globaly, goal, government, guide, happened, helps, hit, hn, identifying, illegally, in_order, increased, indications, individuals, influence, innovation, insights, interagency, interests, intranet, intuitive, intuitively, isafs, isvg, kharda, landowners, likelihood, likely_to, male, minimize, move_into, names, nation, nationals, nipr-based, normative, objectives, operators, opponents, partners, personnel, photos, populates, populating, populations, posting, potentials, presence, pressures, production, promote, quantitatively, realizing, rebuilding, recognized, recommended, relations, representatives, representing

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Table 55.   Newman Group–Period 8 (5–10)

5	126	agencies, airport, algebra, amount, analyst, analytical, array, arts, assessment, authors, bachelor, calhls, calhs, cargo, carnegie, casos, city, clemson, clinic, collaborating, components, comprise, conflict, corporation, counter_to, covers, craft, cultural, cutoff, cutting, databases, demonstrate, depiction, diagram, dilemmas, diversity, drivers, edge, emergency, employers, enforcement, escalation, examining, existing, experience, experiences, expertise, exploring, expressed, extensive, failure, farms, feed, fid, fielding, fists, focusing, follow-on, foreign, formats, framework, fuel, gained, generation, geospatial, graduated, growth, handful, harbors, historical, hospital, hospitals, i2, in-country, in-field, increase, information_technology, infrastructure, inspection, instruction, integrating, intensity, internal, intervention, link, maintenance, makers, manipulation, masaro, matrix, meant, mellon, minutes, modular, monuments, multivariate, murphys, nasser, notebook, organizational, package, pairing, pencil, physical, pictures, pittsburgh, planning, poi, police, police_station, policy-makers, popular, ports, possesses, preparedness, programmer, programming, query, railroad, reasonably, reliable, rely_on, replace, representation, representational, required
6	118	affairs, alerts, algorithm, application, arcgis, aroundme, aspect, assessments, assimilated, assimilation, availability, awards, basically, block, briefing, brokers, candidates, clients, codes, cohesive, companies, complete, concepts, configurable, configuration, configured, connectivity, console, contract, cop, created, customizable, demographics, descriptive, developer, distribution, downloading, dropped, earth, easily, effectively, elementary, embedded, employ, end-to-end, essentially, establishing, examples, expanded, figures, focus, friction, front-end, functionality, fuse, gater, geo-location, geo-tagged, geography, gui, highly, humans, identification, import, influx, integrations, interpreted, ipads, iphones, irapids, itouches, led, leveraged, limitless, listed, lost, lubjlijana, lucrative, managed, managing, map, match, matched, module, modules, multi-level, native, navigate, oda, offered, optimized, oras, pajek, panels, plug-ins, possibilities, practical, procedures, providers, public, purpose, pushing, q2r, qualitative, quantitative, reachback, reason, recognize, recovery, recruitment, refocus, regional, reload, replaces, replicated, represent, representative, represented
7	88	1-mode, 2-mode, android, attention, background, cell, cellular, change, chemical, chemistry, citation, civilian, cognitive, collaborate, collaboration, collectâ€, combines, communications, computation, confinement, contagion, conventional, covert, cp, data-mining, defining, demand, designing, diffusion, disease, distract, dynamics, empirical, epidemics, equipment, extracting, facility, farc, footprint, force, genealogies, genetic, gsm, honor, https, hyperlink, illness, illuminated, in_fact, industry, innovations, instantly, insurgency, interaction, international, internet, large, loan, long_term, mandatory, mass_destruction, meetings, member, metric, molecule, multi-dimensional, multiple, narcotics, natural, naturally, networks, niprnet, non-secure, openatrium, operate, operate_on, operationalize, operatives, organizations, pests, phones, portable, positively, prestige, protein-receptor, protocol, reduce, relate
8	85	ability, academics, accurately, actions, adaptation, advertising, alarmed, ao, apparent, atrap, blocking, bountiful, category, comfortable, community-external, complement, compliant, computational, configure, continuous, course_of_action, cyan, decline, density, depict, descriptors, detect, determining, disappearance, disenfranchised, elites, enhance, expect, extra-regional, focused, governance, governments, grass_roots, grievances, healthy, hosting, idiosyncrasies, improve, improving, incomplete, incorporate, indigenous, initiatives, interact, interpreters, intitiaves, involve, kestrel, ktg, largest, las, lines, local, maintaining, methods, minh, mobilization, naval, navigation, nevada, northwest, observe, obstacle, onr, operation, organization, overwhelmingly, pao, peaceful, populace, population, portion, powerbrokers, produce, quaam, quantify, questioning, quota, relevance, remain
9	74	unclassified, acres, advisor, agricultural, andtook, appear, as_one, astute, attitudes, begun, beliefs, berets, blue, boundaries, cases, choices, chooses, claims, close, colors, comparative, competitive, compiled, corporate, cousins, crops, customize, described, diagrams, disadvantage, dispersion, district-wide, dots, download, enemy, engagements, exploiting, family_members, familys, feel, fighting, filing, fit, free, goals, grabs, green, grown, health, hereditary, indicate, inevitably, intra-tribal, jeribs, khandahar, labeled, lacks, land, literate, locales, lost_in, measuring, neighbors, nephews, official, overlap, overshadowed, owned, ownership, property, receives, red, relative, remains
10	73	action, addition, aforementioned, airports, anthropological, appears, articles, as_is, battalion, believes, boasts, borrowing, bus, centers, challenges, classified, collective, commit, conduct, confirmatory, contribution, core, courses, creating, critically, demographic, departure, designed, economic, established, expanding, expansion, extremely, fellow, fuller, gps, higher-level, impact, implemented, in-progress, initiative, internally, involves, ipr, lab, maps, medical, methodologies, methodology, mining, north, officer-in-charge, ontology, operational, pass_on, pat, picture, politics, preparation, professors, programmable, proudly, published, radio, realï¿½, reasons, reception, recommending, reconnaissance, redeployment, religion, remotely, replication

Table 56.   Newman Group–Period 9

Time period	9	
Newman Modularity Score	0.737	

Group	Size	Members
1	124	accurately, additionally, aforementioned, aggregate, android, apache, application, architecture, authenticated, authentication, band, bases, benefits, cadre, called, capturing, collaborate, collaboration, collect, collected, collection, combination, commercial-off-the-shelf, concept, conduct, configuration, connections, continues, countries, create, customized, data, databasing, deliverables, description, designed, develop, developing, development, devices, divided, enabled, enables, enforcement, ethnographic, evolved, exclusively, exploration, external, focused, focuses, form, fuse, fusionportal, fusionview, goal, hardware, held, hosting, iform, in_order, interview, ios, ipad, iphone, ipod, kit, ku, lamp, lighthouse, linux, local, machines, manage, measurements, mysql, notional, odk, offering, offers, offshoot, on_hand, open-source, operators, overlay, overload, php, plays, population, portal, professors, project, prominent, purpose, purposes, range, refine, released, relies, rendering, reporting, repository, representative, role, secure, service, sharing, simulate, socio-cultural, sociocultural, source, store, structuring, survey, system_components, task, technical, topics, touch, traits, transmission, ultimate, upload, used_to
2	51	accessed, attendance, chsc, components, comprise, comprised, concepts, consist_of, consists, core, educate, emailed, enhance, environments, expose, familiarize, finished, flows, generation, gots, individually, introducing, introductory, lab, labs, lens, managed, map, members, methodology, nested, objectives, operational, participants, payoff, personnel, police, prepares, process, products, program, required, seminar, send, sna, theoretical, traditional, training, transferring, travelling, valuable
3	51	analyst, anlysis, attributes, backbone, bands, bgan, cell, cells, channels, communication, desired, discussed, effectiveness, focusing, frequency, fusion, geo-spatial, geographical, geospatial, influence, instruction, intelligence, link, low-cost, military_operations, modeling, mop, multiple, network, networking, practices, projects, providing, pull, reach, relational, result, reviewing, satcom, satellite, scope, selectable, spatial, statistical, structure, techniques, temporal, thesis, throughput, washington aimed, weighted
4	39	action, allows, alternative, approaches, armed, aspect, behavioral, campaigns, civil-military, coin, collectors, comprehensive, conflict-resolution, cop, counter, counter-insurgency, counter-terrorism, cultural, deployed, dss, examination, force, hunting, indirect, io, iopt, man-hunting, miso, missions, nuanced, planners, post-conflict, psychological, reconstruction, return_to, strategies, teams, understanding, view
5	34	ability, advanced, analytic, analytical, applicable, apply, associated, breed, closely, commands, courses, depiction, emphasized, establishing, gathered, geo-graphical, integrate, learn, mco, methodologies, methods, models, off-the-shelf, operationalize, para, requires, researching, special_operations, sufficient, systematically, taught, theories, validate, visual
6	27	adversaries, analyze, battle, cases, challenging, complete, complex, ctiw, currency, derived, effectively, engaged, exist—but, informed, innovations, insurgency, intervention, irregular, leading, maintain, networked, operatives, picture, problems, solve, terrorism, understand
7	25	accessible, addition, app, apple, appliances, closed, commonly, developed, htc, https, internet, intranet, loan, long_term, motorola, organizations, phones, running, samsung, server, standard, tablets, variety, vendors,
8	21	affairs, capability, controls, coordinated, defined, evaluating, existing, improvement, incorporation, individual, interagency, interagency-coordinated, pieces, programs, record, represent, requirement, shortfalls, systems, technological, terrain
9	20	accomplishments, analyzer, carnegie, detailed, encountered, expected, gtf, invitation, measures, mellon, milestone, mitigation, monthly, official, organizational, participate, performance, reports, risk, risks
10	17	abilities, capital, computer, database, develops, enhances, informs, intellectual, interaction, knowledge, leverage, management, methodologies—nps, produces, skills, transfer, warehousing

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Table 57.   Newman Group–Period 10

Time period	10	
Newman Modularity Score	0.77	

Group	Size	Members
1	73	additionally, advanced, analytic, analytical, ao, assessment, attire, background, brainpower, breed, capturing, collected, collecting, collection, comprised, configuration, continue, criteria, csv, data, depending, description, effective, ems, enable, engaged, entry, experiment, exploiting, field-based, formats, gather, gis, gots, government, haphazard, hardware, identifies, instructions, introduced, leverage, magtf, management, managers, manually, merge, methodology, motion, moves, off-the-shelf, overarching, physical, planners, planning, pom-12, process, project, relational, required, revise, shape, sim, sof, sources, spatial, specifications, stakeholders, storage, structure, systematic, transport, understand, venues
2	52	accuracy, analyze, appropriate, assess, briefs, brigade, caos, chime, cim, cmoc, conduct, consolidate, consolidation, continued, coordinator, damp, develop, distribute, distribution, enclosure, equip, equipment, essence, evaluate, evaluation, facilitate, feedback, fex, fill_out, handheld, handhelds, instructor, issac, jsotf-philippines, laptop, loi, method, oc, path, pelican, phase, quality, rdms, requested, signal, teams, training, trend, usability, user-evaluation, utilize, wcid
3	49	administration, aggregate, android, app, applications, atrium, black, box, capability, cdd, collect, communicate, completely, configurable, conjunction, cpd, custom, customized, databases, development, easily, enforcement, evolves, existing, form, foss, free, icd, independent, infinite, intranet, joint-cim, lower-level, marcorsyscom, more_or_less, odk, open_source, opendatakit, pdt, production, program, record, share, standards, underpins, units, variety, websites, wondering
4	48	aggregates, aggregation, application, at_large, augment, backend, benefit, benefits, breadth, cad, challenge, close, communications, complete, completion, dealing, demonstration, enhance, enhanced, field-tests, focused, fusionportal, goal, hands-on, iform, integrating, investment, lighthouse, linking, loan, long_term, majority, master, maximize, migrate, milestone, overwhelming, pdas, phones, presenter, purpose, real-time, reporting, representative, scope, service, source, technical
5	30	academics, assessments, branch, classroom, cmo, component, cwo2, deputy, execution, experts, foreign, gathered, humanitarian, jabinal, msgt, nation, populace, quantico, resource, rhode, scetc, standardization, stores, subject-matter, supports, tasks, terlizzi, tests, virginia, yntema
6	28	95th, affairs, allied, assigned, cohunna, copland, corps, deliverables, developed, download, downstream, experimentation, fusing, kestrel, main, marforpac, marine, mct, mec, mos, openatrium, operate, pacific, parts, task, understanding, united_states, visualization
7	28	analyst, apparatus, arc, cells, combating, criminal, earth, effectiveness, exists, export, finds, focus_on, focusing, geospatial, improving, increased, instruction, intelligence, link, network, powerful, practices, resiliency, reviewing, techniques, unable, violent, warfighter
8	28	analysts, approval, ave, civilian, clearance, commanders, company, comply, concept, contractors, county, ext, gang, instructors, integrations, intent, interview, isaf, maintain, personnel, police, regulations, secret, seek, senior, sergeant, task_force, watch
9	20	6a5cebda-3334-4980-8544-3773785abfb1, agreement, alternative, alternatives, apple-mail-43-378614411, commercial, content-type, delivered-to, integrate, licensing, mime-version, o14mr19406921ioi, protecting, pst, smtp, superior, x-received, x-smtp-server, x-universally-unique-identifier, z10csp1548345ier
10	15	accomplishments, amount, balance, committed, detailed, encountered, expended, financial, in_reserve, measures, mitigation, monthly, obligated, reports, risks

Table 58.   Newman Group–Period 11

Time period	11
Newman Modularity Score	0.770

Group	Size	Members
1	75	actively, briefing, called, chime, colleagues, collect, collection, concept, connectivity, consolidate, create, customized, data, demonstrated, demonstration, designed, development, done_with, endure, entry, eod, executing, existing, facilitate, form, fuse, geofidelis, gis, handsets, heard, ied, illuminating, in_general, in_order, incorporate, info-gathering, inherit, isaac, latest, lighthouse, likelihood, login, manage, management, manpower, mccim, milestone, networks, nomination, ora, originally, portal, procure, project, pw, rms, run_through, seamless, selected, server, set, sets, source, spatial, spreadsheets, ssd, stand-alone, starting, streamline, suggestions, suite, targeted, tasked, weve, white_paper
2	53	19th, balikitan, cobra, coded, components, concepts, conduct, conducted, consist_of, consists, core, curriculum, cutting, derive, edge, educate, enforcement, evening, event, exercises, expose, familiarize, focused, generation, goal, hosting, in_advance, insights, introducing, introductory, j7, lab, labs, ltg, methodology, mulhollands, nlt, objectives, participants, pd, personnel, practical, pre-deployment, prepares, program, propose, purpose, representatives, researches, seminar, training, travelling, visit
3	47	abilities, ability, advanced, analytic, analytical, application, apply, appropriate, armed, articulate, associated, breed, capital, cells, collectors, commands, courses, deliverables, develops, discussing, emphasized, enables, enter, establishing, force, integrate, intellectual, knowledge, learn, leverage, methodologies, methodologies-nps, ohdaca, operators, process, produces, real, responses, return_to, situations, skills, socio-cultural, systematically, task, text, theories, visual
4	31	analyst, analyzing, applicable, biggest, citp, coding, collecting, concentrate, details, discussed, expertise, focusing, geospatial, instruction, intelligence, learned, lessons, link, local, network, practices, projects, relational, requested, respective, reviewing, sociocultural, special_operations, specializes, teams, temporal
5	29	addition, additionally, agreed, began, centered, collaboration, conference, continue, coordination, cover, cultural, deployment, dynamics, embarking, farc, held, j-2, mec, meetings, mika, period, referred, refine, scd, socio, standing, three-day, understanding, upload
6	25	accomplishments, arriving, award, collected, contract, detailed, developed, documentation, engagement, expect, hca, late, lieutenants, mid, monthly, moved, on-going, planned, products, profile, reports, sipr, sotf, trac, usage
7	25	adversaries, analyze, battle, civil-military, complete, coordinated, counter, counter-terrorism, currency, engaged, exist-but, feedback, flow, gtf, innovations, insurgency, irregular, leading, loop, maintain, operatives, picture, psychological, terrorism, understand
8	24	advantages-disadvantages, aims, chsc, collins, discover, disrupting, eddie, environments, exercise, gang, incorporation, led, lens, members, operational, police, reporting, representative, sherrie, specs, springfield, systems, technical, valuable
9	19	95th, affairs, alongside, brigade, caos, centric, cimdps-is, cjsotf-a, corps, exception, experiment, featured, integrated, marine, msots, rip, sotf-w, speaking_of, wcid
10	18	clarity, delaram, dwyer, fielded, iiimef, iimef, instances, likely_to, lnk, loan, long_term, mef, phones, proposed, rct-1, rct-8, subordinates, unstuck

Table 59.   Newman Group–Period 12

Time period	12	
Newman Modularity Score	0.681	

Group	Size	Members
1	75	academic, afghanistan, alp, app, assistants, audience, augment, backbone, battlefield, briefing, capability, capes, cced, chime, circulation, cjsotf-a, comms, compatible, components, conducting, continue, conus, core, cycle, develop, done_with, downloaded, downrange, enhance, equipment, extremely, fan, findings, gpf, handheld, indicating, integrating, intern, introducing, invitation, isaac, j33, lab, labs, lighthouse, methodological, methodology, methods, oconus, participate, philippines, pre-mission, program, purchases, purpose, real-time, report, seminar, set, sna, sof, speed, stability, strength, suggestions, suite, syncs, teams, technological, train, training, transmission, vso, watched, work_in
2	56	allows, analyst, analysts, annotation, automated, automates, browse, captures, categories, cim, creating, custom, describing, differs, driven, dsf, ease, efficiency, employs, entity, explore, export, flexible, format, framework, functions, generate, generates, growth, identifies, import, increases, intelligent, knowledge, leveraging, marcim, mediawiki, opposed, organize, organizes, outputs, property, query, regular, reporting, represents, semantic, share, structured, supports, tag, view, visualize, wiki, wikipedia, write_up
3	54	affairs, analytic, applications, automatically, benefits, by_no_means, capturing, collect, collected, collecting, collection, create, data, datasets, developed, development, discover, discovery, easily, endless, entities, existing, exploiting, field-collected, fixing, focused, formal, generating, greater, holistic, imported, imports, inflexible, integrated, integrates, intel, interlinking, linked, links, majority, methodologies, overwhelming, portal, properties, relational, relationships, rely_on, semantically, sme, socio-cultural, tagged, tagging, tags, technical
4	43	assessment, assessments, atom, city, civilian, cjtf-hoa, conducted, csv, deployment, designed, discussed, divided, engagement, form, georss, ha, health, hn, hospital, hospitals, improving, inputted, integrations, isaf, ivo, json, listing, measurement, medicine, mgrs, photos, preventive, routine, senior, subforms, suggestion, summary, survey, surveys, thorough, unofficial, village, xml
5	27	blue, combat, complex, county, devolve, effective, environments, gang, green, illuminate, insist, lacks, lens, navigate, networks, operational, physical, proved, red, required, requirement, shape, sponsorship, structure, terrain, understanding, valuable
6	24	apparatus, build, countrys, crime, database, direction, diseases, enforcement, epidemiology, facilities, familiarize, finds, helps, intelligence, medical, mysql, ops, personnel, picture, prevalent, prevent, spread, stored, unable
7	21	ability, advanced, analytical, apply, brainpower, check_out, companys, consists, geo-spatial, hands-on, holding, link, network, operators, point_to, temporal, videos, warfighter, watch, watching, youtube
8	18	annotated, balikatan, comprehensive, consist_of, details, diagnosing, essential, exercise, geospatial, harnessing, illuminating, instability, introductory, investigating, practical, project, purposes, visualization
9	17	analyzing, collaboration, collaborative, conduct, detailed, discussion, displays, empirical, enables, enhanced, facts, field-tests, kind_of, management, sharing, svtc, tabs
10	13	apps, as_one, candidate, concept, led, migrate, package, pdas, phones, proof, smartphones, tablet, tablets

Table 60.   Newman Group–Period 13

Time period	13
Newman Modularity Score	0.658

Group	Size	Members
1	124	accessing, active, adaptation, allowing, android, answered, application, asia, assessing, assessment, balakatan, beaudette, benefits, briefed, build, close, cobra, collaborate, collectors, combination, commercial, commercial-off-the-shelf, commerciallyutilized, compatible, comprehensive, concept, conclusion, configuration, continually, continues, coplink, customization, demonstration, deploy, deployed, description, desires, devices, differences, dramatically, dynamics, ease, employed, employing, employs, equip, evolved, exists, exposing, extremely, fielding, filtered, flexible, focused, free, functionality, fund, gathering, goal, government, hardware, health, holistic, importing, incarnation, independent, instructing, introduces, ios, jolo, kicked, leveraged, lighthouse, loan, long_term, majority, memorandum, milestone, mission, navigating, newer, nuanced, offshoot, on_to, ongoing, open-source, open_source, osd-atl, overwhelmingly, owned, packaging, phones, pilot, platforms, portal, posted, powers, previous, project, public, purpose, refine, representative, seeks, segment, session, sharing, source, southeast, subsequently, supported, supports, tested, threefold, tied, tng, tremendous, ufr, uis, understanding, understood, unique, up-date, wider
2	120	abilities, affairs, aggregate, aggregation, agile, allow_for, analyze, applications, art, attribute, bed, caos, capability, capturing, challenges, cloud-hosted, coding, collect, collected, collecting, collection, complete, computer, content, create, custom, dashboard, data, database, design, develop, develops, driving, economic, enable, enables, entire, ethnographic, exploitation, exploiting, facilitates, feed, for_example, functions, fuse, geographic, geospatially, geospatially-enabled, gis, glut, harnesses, historical, impression, improve, in_order, inexpensive, intelligence, interaction, knowledge, likelihood, low-visibility, maintain, manage, management, marcim, media-rich, method, moved, near-term, nigeria, operators, overload, performed, philippines, picture, powerful, practices, proceed, process, processed, range, reach-back, reinforces, relational, religious, remains, required, reviewing, robust, role-based, running, schema, select, semantic, share, shared, skills, socio-cultural, sociocultural, solely, solving, stored, structured, suit, tailor, tailored, technical, templates, transfer, turning, ultimately, unclassified, underlying, update, usage, used_to, views, visualized, warehousing, wiki
3	101	advanced, analytic, analytical, analyzed, analyzer, app, attribute-based, basilan, behinds, blue, breed, bring_in, centrality, characteristics, classroom, clearly, communities, consisted, core, courses, customize, define, demonstrated, describing, developed, emphasized, encap, enterprise, exercise, exercises, exploited, exposed, exposure, finally, focuses, formats, fundamentals, gap, global, gravity, hands-on, illuminating, inform, ingrain, intellectual, introduced, introducing, iteration, lab, labs, leave_behind, leaves, medcap, methodologies, methodology, metrics, mindanao, mtt, network, networking, ocm, on-site, operational, operationalize, ora, organizational, outstation, package, participants, practical, practitioners, pre, products, programs, property, proved, providing, ready, research_and_development, result, risk, seeking, segments, series, set, sit_on, sitrep, sna, sof, tablets, taught, teaching, technological, training, unlimited, valuable, variety, visits, visual, visualizations, visualizing
4	82	7s, accept, adjustment, allowed, bkt, boost, cambodia, cfsocc, chsc, cjsotf, collaboration, conduct, continued, contract, contracting, counter, countries, county, deliberate, deliverables, doctoral, drop_in, drug, equipment, execute, execution, expedite, force-philippines, furnished, gang, gfe, impact, incorporation, indonesia, integrate, integrated, japan, korea, legal, lh, limit, marketing, massachusetts, members, mipr, mongolia, months, opportunity, orders, payment, plagued, pmt, portion, positive, processes, purchase, purposes, raised, real-time, receptiveness, reflected, relations, remain, report, resolve, resubmitting, singapore, sotf-w, south, special_operations, springfield, surrounding, systems, task, task_force, thailand, troopers, two-fold, undesirable, vehicles, violence, voucher
5	52	accessible, accomplishments, adapt, adequate, adopt, aggregated, applied, assess, browser, cellular, charts, cities, collaborative, concert, context, conversation, coordinated, detailed, disrupting, easily, elements, encountered, explosive, frameworks, graphs, illuminate, improvised, indigenous, influencing, interagency, leaving, map, maps, measures, mitigation, monthly, multinational, networks, non-human, notional, partners, population, reports, risks, selected, situation, spectrum, tables, terrain, understand, web, wireless
6	50	ability, activity, analyst, apply, combating, conducted, conferences, conflict, cooperation, criminal, demonstrate, dynamic, effectively, elders, enhance, feedback, focusing, follow_up, geospatial, highlight, improvements, improving, initiatives, instruction, investment, link, local, maximize, meetings, modeling, operator, period, permitting, planning, presentation, projects, query, reporting, resilience, resiliency, respond_to, spreading, structure, temporal, utilize, village, villagers, violent, visualization, word
7	48	afghanistan, amount, balance, bypass, circles, committed, considerable, decidedly, depicts, diagram, disagreed, district, dots, ego, elder, examine, expended, financial, friction, friendly, gain, green, haji, in_reserve, increased, individual, individuals, influence, isaf, juma, jumas, khakrez, mohammad, obligated, one-step, possess, red, reduce, reluctance, removed, represent, reveals, son, squares, strong, taliban, tribal,
8	47	additionally, addressing, articles, civil-military, cmo, combat, copied, corp, corps, cultural, decision-making, development, directorate, documentation, expeditionary, experimentation, exploration, focus_on, force, guide, hast, humanitarian, implementing, investigate, kahuna, learned, lessons, magazine, marforpac, marine, mec, mef, militarys, nature, objective, occur, pacific, pending, por, proposal, requirement, survey, sustainable, teams, transition, united_states, work_in
9	41	action, alternative, approaches, battle, campaigns, coin, conflict-resolution, counter-insurgency, counter-terrorism, craft, crafting, designed, engaged, examination, fid, ied, indirect, initiated, intervention, io, irregular, iw, joc, led, man-hunting, missions, operatives, osd-at, policies, post-conflict, program, rates, recalculation, reconstruction, record, strategies, tasked, transitioned, uw, village-stability, vso
10	22	associated, capstone, cases, challenging, complex, consortium, derived, environments, field-tested, flows, gathered, handoff, homeland, informed, methods, models, problems, prototype, served, solve, sufficient, validate

Table 61.   Newman Group–Period 14

| Time period | 14 | |
| Newman Modularity Score | 0.678 | |

Group	Size	Members
1	64	allow_for, analyzing, audio, collected, collection, collects, complement, component, computer, conduct, data, database, definition, devices, dissemination, efficiencies, enable, enables, enhanced, excel, expertise, extract, facilitate, functionality, gathered, gots, gps, individual, interaction, interviews, introduced, iphone, iteration, knowledge, leverage, lexicon-compliant, majority, management, ora, overload, pd, pertinent, photo, processed, qualitative, quantitative, relational, requested, rolodex, sensors, sna, socio-cultural, sound, spreadsheets, structured, transfer, unclass, underway, unlimited, vast, visualization, visualizing, warehousing,
2	48	0m, 5m, advantage, apps, attac-cidne, background, bca, called, cexc, combat, commercial-off-the-shelf, contacts, continued, continues, contracting, deliverables, demonstration, departure, desired, developed, evaluation, existing, fielded, findings, focuses, formal, hardware, ied, inception, inclusive, incorporation, lighthouse, loan, long_term, months, naval, ongoing, phones, postgrad, project, recommendations, refine, requirement, source, synopsis, systems, tablets, vice
3	47	alts-analysis, android, application, applications, assessing, benefit, cjsotf-a, cjsotf-p, configuration, constructs, conus, documented, documents, downrange, effectiveness, enhances, eod, exercises, fieldex, functional, gap, iedna, instance, integrated, investments, jieddos, measure, measures, meu, migrate, milestone, moe, one-way, operational, opeval, outcome, outcomes, pending, pmo, programmatic, pt, speed, spiral, spirals, teu,
4	41	alongs, appropriate, assessment, attac, begun, board, ccrb, cidne, coic, commercial, compete, conducted, contractors, county, databasing, functions, government, iedna , interviewed, investment, jet, legacy, mandated, maximize, multiple, offered, offering, por, problematic, processes, program, programs, record, representatives, sell, springfield, tboc, techdiv, usacil, vehicle, visits
5	35	2x, attended, collect, commanders, courses, customized, dcgs-xx, define, demonstrated, deploy, deployed, designed, distributed, download, enforcement, feedback, form, gtf, handsets, improve, integrate, interoperability, interview, labs, le, lh, massachusetts, measurable, originally, previous, promotes, sgt, training, units, visit
6	32	american, capability, cellular, criminal, dollars, employment, enhance, first-responders, gang, hoped, influence, influencing, informed, initiatives, internet, leave_behind, leveraging, makers, map, networks, operations network, organizations, proof-of-concept, reached, rms, selected, spending, store, stored, task_force, tracnet, understanding
7	26	afpak, analyst, coordinates, crime, crucial, demonstrate, focusing, gather, geospatial, hand, hands, hosted, instruction, link, make_sure, network, networking, operator, operators, police, reaches, significance, structure, temporal, understand, workflow
8	21	actors, augmentation, bala, biographical, dat, district, entity, interact, issa, local, mohammad, morghab, paper, pencil, proposed, providing, provincial, reverted, storage, teams, tribe
9	21	aid, arrived, assets, combining, core, cutting, edge, equipment, feel, free, grad, lab, methodologies, methodology, on_board, platforms, repository, sociocultural, taught, thing, threat
10	16	analytic, analyze, assessments, breed, conductsocialnetworkanalysis, design, develop, embraced, governance, investing, open-source, report, risk, shifts, tenets, tied

Table 62.   Newman Group–Period 15

Time period	15	
Newman Modularity Score	0.686	

Group	Size	Members
1	39	afb, applications, collaborative, collected, collection, consists, data, deploy, deployment, discoverable, distributed, distribution, enables, equipped, exploit, family, ft, fusion, hinder, infrastructure, ingestion, knowledge, lighthouse, link, macdill, management, manipulation, non-destructive, process, proved, requirement, robust, sharing, storage, structured, supported, supports, transport, transported
2	36	afghanistan, africa, analytical, bridge, capability, central, cjsotf-a, co-located, cross-domain, define, deployable, djibouti, expeditionary, expeditionary-as, hoa, horn, jsotf-ts, ncr, ops, philippines, pm, project, purpose, relevance, required, requires, server, siprnet, socsouth, sojtf-a, sotfs, south, sustainment, trans-saharan, un-disturbed, urgently
3	24	advanced, analytic, combines, cross, domain, exploitation, explosive, functionality, geospatial, hda, iedna, improves, improvised, investment, leveraging, mature, methodology, mining, network, operationalizing, represents, temporal, understand, upheld
4	20	attacking, broader, complementing, disrupt, effectively, enterprise, execute, global, identifying, ied, influencing, mission, nation, nations, networks, pns, reduce, share, sof, threat
5	20	cycle, economic, existing, fy15, leverage, measures, new-start, nlt, outcomes, pom, procedures, program, programs, record, sustained, system_components, tactics, techniques, transition, ttps
6	19	ability, bices, cellular, collect, commercial, commonly, cx-i, devices, edge, handheld, internet, jwics, lighthouses, non-classified, radios, secure, sipr, transfer, usb
7	16	backbone, commands, component, core, dcgs-sof, dib, enable, integrated, lab, operational, special_operations, subordinate, theater, tsocs, united_states, units
8	7	bragg, coop, germany, nc, socafrica, soceur, stuttgart
9	7	cycles, developmental, execution, experts, iterative, subject_matter, training
10	7	determined, developed, evaluated, methodologies, nexus, peering, systems

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